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SPOLIA ZEYLANICA.

ON SOME ABERRATIONS OF CEYLON BUTTERFLIES.

By E. Ernest Green, F.E.S., F.Z.S.

Entomologist to the Government of Ceylon.

(With two Plates.)

THE aberrations here described have (with the exception of Nos. 1 and 11) been deposited in the collection of the Colombo Museum. I take this opportunity of thanking Miss Black and Messrs. Ormiston, de Mowbray, and Saunder for their generous donations, and Mr. John Pole for the loan of his specimens.

1. *Mycalesis* (*Orsotricæna*) *meda*, Fabr., race *mandata*, Moore. ♂

Pl. II., fig. 8.

Captured at Nawalapitiya by Mr. J. Pole.

The underside lacks the usual sharply-defined white band. Its position is indicated only by a paler brown line on the fore wing and a diffused whitish band on the hind wing. In this character it approaches the dry season form of the typical Indian race (*meda*) in which—according to Bingham—the transverse white band on the underside is sometimes obsolescent. The Ceylon race (*mandata*) differs from *meda* "in the white discal band on the underside, being very much broader and proportionately more attenuate apically."

(In coll. John Pole.)

2. *Neptis varmona*, Moore. ♂

Pl. I., fig. 4.

Taken at Kandy, January, 1911.

Differs from type in the reduction (almost to obsolescence) of the subterminal series of spots on the fore wing; in the diffused character of the sub-basal white band on the hind wing, and the shifting of the post-discal series of spots to a subterminal position. This arrangement results in an unusually broad black area between the sub-basal and the post-discal bands which gives a very distinct character to the insect. In these characters it apparently approaches the race *andamana* of Moore, as described by Bingham (Faun. B. I., " Butterflies, " Vol. I., p. 325).

On the underside the ground colour is darker than usual, owing to a general blackish suffusion, and all the spots have diffused instead of sharply defined borders.

(Colombo Museum, Reg. No. 2,554.)

3. *Vanessa* (*Pyrameis*) *indica*, Herbst. ♀

Pl. I., fig. 1.

Two precisely similar aberrations of this form were bred from a batch of larvæ sent down from Diyatalawa (4,367 ft.) to Peradeniya (1,562 ft.), where they pupated in the warmer climate. Of the four successful emergences, two individuals were normal and two aberrant. The latter have been described in a previous number of this Journal (Vol. VII., Part XXVIII., p. 215), but without any figure. A very similar aberration has been described and figured in a Paper by Mr. P. J. Lathy, " On some Aberrations of Lepidoptera from the Collection of Herbert J. Adams " (Trans. Ent. Soc., London, 1904, p. 65).

(Colombo Museum, Reg. No. 2,559.)

4, 5.—*Argynnis hyperbius*, Johanssen ♂ and ♀.

Pl. I., figs. 5, 7.

These two specimens, evidently members of the same brood, were caught by Mr. G. B. de Mowbray on an estate in the Maskeliya district in January, 1905. They were taken on the same spot but on separate occasions, within four days of each other. They are distinguished by a suppression of

certain spots and a marked crowding together of those on the discal area of both wings. The differences from normal may be particularized as follows :—

Fore wing.—The basal transverse streak is missing from the cell. The two innermost spots in interspace 1—normally widely separated—are here brought into close apposition in the male, and united into a single elongate spot in the female. The spots of the discal series are shifted inwards to the extreme base of the several interspaces, the spot on interspace 2 (of the female) being completely suppressed. The broad transverse streaks at the apex of the cell are more or less confluent and (with those of the discal series) form a crowded central patch of black spots.

Hind wing.—There is a similar but less strongly marked crowding of the discal and cell spots, and the discal spot on interspace 1 is missing in both sexes.

(Colombo Museum, Reg. Nos. 1,610 and 1,611.)

6. *Argynnis hyperbius.*

Pl. I., fig. 6.

This interesting gynandromorph was caught by Mr. F. G. Saunder at Nuwara Eliya (date uncertain), and presented to the Museum. The left wings are those of a typical male, and the right wings of a typical female hyperbius. The external genital organs are of the male type.

(Colombo Museum, Reg. No. 2,635.)

Mr. F. Hannyngton, of Madras, gives me the following references to similar freaks of this species :—

"Journ. Bombay Nat. Hist.," Vol. VIII., p. 152. This example is said to have been a male (as regards genitalia), but to have had a wing pattern of the female type on one side.

"Journ. As. Soc., Bengal," Vol. LXIII., p. 9. Figures a bilateral *Argynnis niphe* (— *hyperbius*), with male genitalia. Bred by Mrs. Robson. These two references apparently refer to the same individual.

Mr. Hannyngton also mentions that a Mr. Wilson, late of Ceylon, took a gynandromorph of this species on Mount Pedro (Nuwara Eliya) some years ago.

7. *Talicada nyseus*, Guerin. ♂

Pl. I., fig. 2.

Differs from normal in the presence of a conspicuous subquadrate white patch on the inner area of the hind wing (upper side), just within the black area, occupying interspaces 1, 2, and 3. The underside appears to be quite normal.

(Colombo Museum, Reg. No. 2,771.)

Three separate examples of this aberration have been taken by Mr. W. Ormiston at Haldummulla : the first (which is the subject of the figure) in January, 1902, the other two in 1912. It is probably an hereditary aberration.

Mr. Ormiston informs me that, in one of his specimens, the white spot on the hind wing is greatly enlarged, forming a large lunate patch extending almost across the wing.

8. *Talicada nyseus*, Guerin. ? ♀

Pl. I., fig. 3.

This particular specimen was taken by Mr. John Pole at Trincomalee. I have seen similar examples from the Kandy District. The aberration consists in the replacement of the red area (on both upper and under side of hind wing) by a pale buff tint. The specimen appears to be a female, but the body is so coated with fungus that it is difficult to make out the form of the genitalia.

(Colombo Museum, Reg. No. 660.)

9. *Delias eucharis*, Drury. ♀

Mr. Ormiston has sent me two female examples of this species, in which the usual white areas of the upperside of both wings are strongly suffused with sulphur-yellow. The yellow areas on the underside are rather more intense than in the typical form. In one example (No. 2,782) there is a general infuscation of the upper surface of the fore wing. Both of these specimens were taken in the Haldummulla district.

(Colombo Museum, Reg. Nos. 2,777 and 2,782.)

10. *Ixias marianne*, Cramer. ♂

Pl. II., fig. 9.

A more or less melanistic form : the orange area on apical half of fore wing dull and brownish ; the white area of both wings grayish. On the underside of the fore wing the whole of the cell and median area are deeply suffused with brown. Underside of hind wing normal.

Taken at Kirinda, Northern Province, March, 1899, by Mr. W. Ormiston.

(Colombo Museum, Reg. No. 2,772.)

11. *Colotis* (*Teracolus*) *etrida*, Boisd, race *limbata*, Butler, ♂

Pl. II., fig. 10.

This aberration, taken by Mr. John Pole at Hambantota in August, 1895, may be described as an albinism, the usual orange patch being replaced by chalky white intermixed with a few orange scales which give a very faint pink tinge to the apical area. The pattern of the underside is normal.

(In coll. John Pole.)

12. *Papilio hector*, Linn. ♀.

Pl. II., fig. 11.

This interesting aberration was captured, on the wing, by Miss Sheila Black at Chilaw, in March, 1912.

The fore wing is quite normal. On the hind wing, the usual conspicuous crimson spots have been completely suppressed. There are greenish blue reflections on the internervular spaces on the hind wing. The usual red pattern is present on the body.

(Colombo Museum, Reg. No. 2,773.)

13. *Papilio demoleus*, Linn. ♂

Pl. II., fig. 12.

This striking aberration of *demoleus* was taken by Mr. W. Ormiston near Wellawaya in November, 1906.

On the upper side of the fore wing there is a complete suppression of the usual submarginal series of yellow spots. The discal spot on interspace 6 is enlarged and extended inwards as far as the cell, and the greater part of the cell is occupied by a large yellow patch. On the hind wing the usual spots


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C. greeni, Desneux.

"Ann. Soc. Ent. Belg.," LI., p. 3 (1907).

In stems of living tea bushes. Also in stems of *Anacardium* and other trees. Occurs more commonly at lower elevations. Ambalangoda ; Kalutara ; Yatiyantota ; Jaffna. Taken also at Peradeniya.

C. domesticus, Haviland.

"Journ. Linn. Soc. Lond.," XXVI., p. 374 (1898).

In window and door frames of buildings, in furniture, shelves of almirahs, &c. The presence of this species is indicated by small heaps of egg-like pellets of excreta which collect below the articles that contain the termites. Occasionally the insects emerge from the wood and are found congregated in masses in the open. Peradeniya.

Sub-Gen. *Glyptotermes*, Froggatt.

C. (*G.*) *ceylonicus*, Holmgren.

"Termitenleben auf Ceylon," p. 189 (1911).

In decaying logs and branches. Recorded only from Peradeniya.

C. (*G.*) *dilatatus*, Bugnion.

"Mem. Soc. Zool. Fr.," XXIII., p. 137 (1910).

In stems of living tea bushes and other trees. Recorded only from the low-country. Avisawella ; Kegalla ; Ratnapura ; Udagama ; Ambalangoda.

Fam. MESOTERMITIDÆ, Holmgren.

Gen. *Leucotermes*, Silvestri.

L. ceylonicus, Holmgren.

"Termitenleben auf Ceylon," p. 190 (1911).

A troublesome domestic pest, destructive to woodwork, packing cases, &c., in outhouses. Taken also in a dead Grevillea stump. Peradeniya ; Ukuwella.

Gen. *Coptotermes*, Wasmann.

C. ceylonicus, Holmgren.

" Termitenleben auf Ceylon," p. 192 (1911).

Occurs commonly under decaying logs of wood ; also about buildings, where it is destructive to deal packing cases. Has been recorded as damaging books, in damp situations, the wood of tea chests, and window frames in a tea factory. Peradeniya ; Matale ; Lindula ; Nalanda ; Trincomalee ; Rattota ; Ratnapura ; Henaratgoda ; Ambalangoda ; Jaffña.

Gen. *Arhinotermes*, Wasmann.

A. flavus, Bugnion.

" Mem. Soc. Zool. Fr.," XXIII., p. 117 (1910).

Discovered by Dr. Bugnion in stems of " Mangrove." Ambalangoda.

Gen. *Termitogeton*, Desneux.

T. umbilicatus, Hagen.

" Zool. Bot. Ver. Wien," p. 472 (1858).

A rare jungle species. Hantane (Kandy District), 3,000 ft.; Ramboda, 4,000 ft.

Fam. METATERMITIDÆ, Holmgren.

Gen. *Termes*, Linn.

T. horni, Wasmann.

" Zool. Jahrb.," XVII., Pt. I., p. 111 (1902).

A comparatively large species. Common in decaying trees and in soil treated with cattle manure. Nests in the soil, without conspicuous mounds. Widely distributed. Kandy ; Peradeniya ; Kotmale ; Haputale ; Diyatalawa ; Ruanwella ; Avisawella ; Ambalangoda ; Hambantota.

T. ceylonicus, Wasmann.

" Zool. Jahrb.," XVII., Pt. I., p. 113 (1902).

Intermediate in size between *horni* and *redemanni*. Nests in the ground, without superstructure. Attacks roots of diseased or dying plants and trees. Peradeniya ; Yatiyantota ; Ratnapura ; Balangoda.

T. redemanni, Wasmann.

" Wien. Ent. Zeit.," XII., Pt. 7, p. 239 (1893).

The commonest of the mound-building species in Ceylon. Widely distributed. Kandy ; Colombo ; Ambalangoda ; Trincomalee ; Hambantota ; Jaffna ; and probably throughout the Island.

T. obscuriceps, Wasmann.

" Zool. Jahrb.," XVII., Pt. I., p. 113 (1902).

Another common mound-building species. The mounds indistinguishable from those of *redemanni*, but the insects easily recognizable by their dark brown heads. Apparently not so widely distributed as the previous species. Recorded from Peradeniya and Diyatalawa.

T. escherichi, Holmgren.

" Termitenleben auf Ceylon," p. 195 (1911).

A small species, occurring in dead tree stems and under decayed logs. Peradeniya.

T. preliminaris, Holmgren.

" Termitenleben auf Ceylon," p. 196 (1911).

While describing this as a new species, from winged adults caught " around a lamp at the Peradeniya resthouse," Dr. Holmgren suggests that it may possibly be referable to some other species of which the adults are as yet unknown.

T. taprobanes, Walker.

" Cat. Neur. Brit. Mus.," p. 522 (1853).

(Syn. *peradeniyæ*, Holmgr. " Termitenleb. Ceyl.," p. 197.)

This species has hitherto been unrecognized by recent workers. Dr. Holmgren has now identified specimens from Peradeniya and Koslanda as referable to this species, but suggests that it is equivalent to *horni*. He also relegates his *peradeniyæ* (described from winged adults only) to *taprobanes*.

T. fatalis, König.

"Schrift. d. Berlin Naturf.," IV., p. 1 (1779).

Holmgren gives Ceylon as a locality for this species, probably on the authority of Hagen ; but he doubts its generic position. It is said to be the common mound-building termite of Tanjore, and its occurrence in Ceylon is doubtful.

T. brunneus, Hagen.

"Linn. Ent.," XII., p. 133 (? date).

Soldiers said to be intermediate in size between *horni* and *ceylonicus*. Precise locality uncertain.

T. estheræ, Desneux.

"Ann. Soc. Ent. Belg.," LI., p. 5 (1907).

A very large species with soldiers of two or more sizes. Larger soldier with an enormous head and powerful jaws. Hambantota.

(Bainbrigge Fletcher is of opinion that this name will have to give place to *convulsionarius* of König. "Schrift. Berl. Naturf.," IV., Pt. I., p. 24 (1779)).

Gen. *Microtermes*, Wasmann.

M. globicola, Wasmann.

"Zool. Jahrb.," XVII., Pt. I., p. 116 (1902).

A very small species, constructing chambers and small spherical combs in the walls of mound-building termites. Precise locality undetermined.

M. macronotus, Holmgren.

"Termitenstudien," III., p. 43 (1912).

Recorded, without description, from Ceylon.

Gen. *Microcerotermes*, Silvestri.

M. bugnioni, Holmgren.

"Termitenleben auf Ceylon," p. 203 (1911).

A minute species, found under logs of wood, in hollow stems of coconut palms, &c. Ambalangoda ; Maha Illuppallama (Anuradhapura District).

M. greeni, Holmgren.

" Spolia Zeylanica," VIII., Pt. XXXII, p. 284 (1913).

Distinguished, by Dr. Holmgren, by the smaller size of the soldier.

M. cylindriceps, Wasmann.

" Zool. Jahrb.," XVII., Pt. I., p. 121 (1902).

Holmgren (in Escherich's " Termitenleben auf Ceylon," pp. 203, 204) records this species from Galle, " in decayed pieces of stem."

Gen. *Eurytermes*, Wasmann.

E. assmuthi, Wasmann.

" Zool. Jahrb.," XVII., Pt. I., p. 124 (1902).

Recorded from the collection of Dr. Escherich as " in association with *Termes obscuriceps;* and in earthen galleries under a stone, in the jungle." My own acquaintance with the species consists of the discovery of a small procession (containing winged adults and workers) travelling—quite exposed—across a bare compound. They were emerging from one hole and entering another at a distance of about five yards.

E. ceylonicus, Holmgren.

" Termitenstudien," III., p. 83 (1912).

Noted as a new species, but without description. Bainbrigge Fletcher (in litt.) suggests that, as Holmgren records *assmuthi* from Bombay only, it is probable that he has separated the Sinhalese species as distinct.

Gen. *Capritermes*, Wasmann.

Species of *Capritermes* may be recognized by the long twisted asymmetrical mandibles of the soldiers. The abdomen of the workers is elongated and packed with dark material. They are usually found in association with mound-building termites ; but also occur, independently, under stones and rocks. The differentiation of the species is difficult, and it is uncertain how many occur in Ceylon.

C. ceylonicus, Holmgren.

"Termitenleben auf Ceylon," p. 204 (1911).

Determined, by Dr. Holmgren, from specimens collected by Dr. Escherich in nests of *Termes obscuriceps* at Peradeniya.

C. incola, Wasmann.

"Wien. Ent. Zeit.," XII., Pt. 7, p. 242 (1893).

In nests of *Termes obscuriceps*. Peradeniya ; Kurunegala ; Ambalangoda.

C. longicornis, Wasmann.

"Zool. Jahrb.," XVII., Pt. I., pp. 126–128 (1902).

Dr. Holmgren doubts if this is specifically distinct from *incola*.

C. speciosus, Haviland.

"Journ. Linn. Soc. Lond.," XXVI., p. 413 (1898).

Doubtfully recorded from Trincomalee.

Gen. *Hamitermes*, Silvestri.

H. quadriceps, Wasmann.

"Zool. Jahrb.," XVII., Pt. I., p. 123 (1902).

Under stones. Ambalangoda ; Peradeniya.

H. ceylonicus, Holmgren.

"Termitenstudien," III., p. 91 (1912).

This is at present a "nomen nudum." The name will probably replace *H. quadriceps* for the Ceylon species.

Gen. *Anoplotermes*, Fr. Muller.

A. cyclops, Wasmann.

"Zool. Jahrb.," XVII., Pt. I., p. 161 (1902).

Under stones and logs of wood. Peradeniya ; Maha Illuppallama.

Anoplotermes is distinguished by the absence of the soldier caste. The workers might readily be mistaken for those of *Eutermes*, of which Dr. Holmgren considers this genus to be an off-shoot.

Gen. *Eutermes*, Heer.

The soldiers of *Eutermes* are readily distinguishable from those of all other genera by the presence of a long tubular frontal process on the head.

E. monoceros, König.

"Schrift Berl. Nat.," IV., 17, p. 25.

The common black termite of Ceylon. It constructs its nests in hollow stems and branches of trees, guarding the entrances by pendent masses of black material (composed of the excreta of the insects). Long processions of the termites, sometimes extending for several hundred yards, may often be seen crossing the roads. Found throughout the Island, up to about 2,000 ft.

E. inanis, Haviland.

"Journ. Linn. Soc. Lond.," XXVI., p. 425 (1898).

Recorded by Dr. Bugnion, from Ambalangoda.

E. rubidus, Hagen.

"Linn. Ent.," XIV., p. 117 (1860).

A widely distributed species. Found under stones, and forming small piles of fine earth on the surface of the soil. Peradeniya; Anuradhapura; Ambalangoda; Diyatalawa.

E. biformis, Wasmann.

"Zool. Jahrb.," XVII., Pt. I., p. 133 (1902).

Possibly a variety of *rubidus*. Galle; Ambalangoda. Both *rubidus* and *biformis* have soldiers of two sizes.

E. ceylonicus, Holmgren.

"Termitenleben auf Ceylon," p. 197 (1911).

(? = *inanis* var. *horni*, Wasmann.)

Nests in decayed wood. Constructs galleries (of earthy or ligneous materials) extending up the trunks of trees. A widely distributed species. Peradeniya; Kadugannawa; Ratnapura; Trincomalee; Passara; Diyatalawa.

E. hantanæ, Holmgren.

"Termitenleben auf Ceylon," p. 198 (1911).

A rare species; recorded from the Hantana range only.

E. escherichi, Holmgren.

"Termitenleben auf Ceylon," p. 199 (1911).

Collected by Dr. Escherich in a nest of *Termes obscuriceps*. Peradeniya.

E. oculatus, Holmgren.

"Termitenleben auf Ceylon," p. 200 (1911).

Described from winged adults only. Peradeniya. Possibly the winged stage of *E. escherichi*.

E. perparvus, Holmgren.

"Termitenleben auf Ceylon," p. 201 (1911).

Also described from winged adults only, collected by Dr. Uzel at Peradeniya and Henaratgoda.

E. longicornis, Holmgren.

"Spolia Zeylanica," VIII., Pt. XXXII., p. 283 (1913).

On stems of "Giant Bamboo" (*Dendrocalamus giganteus*); also in a nest of *Termes obscuriceps*. Peradeniya.

E. lacustris, Bugnion.

"Compt. Rend. Sci. Soc. Biol." (Fr.), LXXII., p. 1091 (1912).

In stems of "Kaju-nut" (*Anacardium*), *Hevea*, and *Elæocarpus*. Ambalangoda ; Kalutara.

Distinguished from all the other local species of *Eutermes* by the dark brown heads of the soldiers.

ON THE MINUTE STRUCTURE OF THE POISON-GLAND OF THE COBRA (NAIA TRIPUDIANS).

By Dr. G. Bobeau.

Prepr. d' Histologie à la Faculté de Mèdicine de Paris.

(With two Plates.)

AMONG all the works on the fine histology of the poison-gland, there are few (except Emery's*) giving a description, both general and detailed, of the gland of the venomous Colubridæ. It may be of interest, therefore, to record my investigations into the structure of the poison-gland of *Naia tripudians* by means of modern histological methods.

I have myself collected many of the poison-glands during my recent travels in Ceylon and British India. Several were given me by Dr. J. Pearson, Director of the Colombo Museum, to whom I again offer my sincere thanks.

I will first describe briefly the methods employed; then the microscopical anatomy by means of interpretations from whole sections; thirdly, I will give a detailed description of the glandular cells with their cell-workings; and finally, I will discuss the physiological significance of each component part of the poison-gland.

I.—*Technique.*

The glands which I examined were removed immediately after the snakes had been killed. The killing was done by suddenly cutting the neck which left the tissues in a definite physiological state. Some of the snakes had been starved; others had eaten two, four, six, or more days before; some had bitten (into a cambric); others in a state of fury had not bitten at all. I was therefore able to obtain all the grades of the cellular and glandular secretions.

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* Emery, Carl. Ueber den feineren Bau der Giftdrüse der Naja haje. (Arch. f. Mikr. Anat. Bd. 11., 1875, s. 561–568. Taf. XXXIII.

Immediately after the glands had been removed they were divided into fragments and placed in the following fixing solutions :—

Bouin's liquid (picro-acetic, formalin).

Champy's liquid (bi-iodide of mercury, formalin).

Regaud's liquid (bi-chromate de potasse, formalin).

Benda's liquid (acide osmique—acide chromique).

Some glands were fixed whole in formalin, in order to study the microscopical anatomy in its entirety. After fixation the fragments were immersed in paraffin and cut into sections of 1/200 mm. or 1/400 mm. in thickness by Minot's microtome. To stain the sections I utilized the following :—

Hematein-eosin.

Heidenhain's ironized hematoxylin.

Prenant's eosin, vert lumière, ironized hematoxylin.

Safranin, green.

Benda's krystallviolet.

II.—*Microscopical Anatomy.*

If a complete section of the whole length of the poison-gland and its excretory duct be examined under low power one immediately observes that two kinds of substances can be distinguished, one a connective and peripheral substance, the other, and most important, a glandular and central substance.

There are, therefore, in a poison-gland two things—first the fibrous capsule, and within the fibrous capsule that most interesting part, viz., the part where the poison is formed.

The complete longitudinal section of the poison-gland is bottle-shaped (fig. 1), the neck part of which becomes the excretory duct. The fibrous capsule is thickest in the broad part of the gland and becomes thinner as the gland narrows. Here and there we see that the capsule forms a connective network, in which are found sections of blood-vessels, lymph-vessels, and nerves. The fibrous structure and the lymphatic spaces are particularly noteworthy.

The central portion, which we have seen to be alone glandular, is divided into two quite different regions. First, there is the bulky part occupying the body of the bottle which is, properly speaking, the poison gland. Secondly,

there is the other part which is situated in the neck of the bottle, but is only a mass of mucous glands.

That part in which the poison is produced appears to be composed of a considerable number of partitions which support the glandular cells. These partitions are relatively rectilineal and radiate on a sort of axial pivot, cutting the gland into elongated lobes which are also irregularly triangular. The interior of these lobes is filled by the poison which turns red if the section is stained with eosin, intense black if placed in ironized hematoxylin. These lobes, more or less regular, do not reach as far as the capsule. Between these and the capsule there are other lobes, smaller, more irregular, and compressed; these are continuous with the principal lobes. Their structure is identical and consist of a cavity containing the poisonous secretion and lined with the glandular epithelium. Summing up, we see that the poison-gland, properly speaking, consists of partitions lined with glandular cells and poison-lakes. The latter are the product of the former, and although in the section itself, the poison-lakes occupy by far the greatest space, the fundamental part is the glandular epithelium.

The anterior mucous part is composed of " acini," which are continuous with the excretory duct itself, or first with a kind of " reservoir " which communicates with the duct. This duct is formed of several parallel conduits situated in connective tissue.

III.—*Histology.*

I give below a description of the glandular epithelium and of the manner in which the poison is elaborated.

If a section of a poison-gland stained by ironized hematoxylin be examined under a medium power one sees around the poison-lakes, coloured black, the glandular epithelium in which three parts are recognizable (fig. 2). Adjacent to the poison-lakes there is a stratum finely granulated and black as ink. Next there is a more lightly-coloured region, and finally, a layer more deeply coloured, which betrays the existence of the nuclei. As the glandular lobes are adjacent to each other we find the epithelia almost in contact at their bases and separated only by a very fine connective band. Thus, for example, between two patches of black we find six small

bands, three of them belong to one lobe, and the three others to a second lobe. The granulated bands farthest off are adjacent to their respective poison lakes.

If the cells of the glandular epithelium be examined in their normal state of secretion under high power the following structure may be determined.

The cells of the glandular epithelium (fig. 3) are regularly prismatic (they are, therefore, in longitudinal sections rectangular). They are about 30 μ in height and contain near the base a deeply stained nucleus from 7 to 8 μ. in width.

The cytoplasm is particularly interesting to examine in sections fixed with Regaud's liquid, for one can then see the mitochondrial substance. This substance is considered to-day as the most active portion of all the cytoplasm, for it plays the chief part in the elaboration of the products of the secretion.

In the cells shown in fig. 3 several zones may be recognized in the cytoplasm: (1) at the base of some cells below the nucleus a quantity of very fine granulations (mitochondriæ) can be seen, and in others small filaments (chondriocontes); (2) at the sides of the nucleus the masses of granulations seem to continue into a kind of chain of beads (chondriomites) which generally run along the lateral walls of the cell; (3) above the nucleus a cytoplasmatic space is found free from granulations; (4) at the free end of the cell are granules far more voluminous than the mitochondriæ (their breadth can reach to 2 or 3 μ). These are what Launoy* calls "Venogen's granules." In other cells one sees alongside the granules, plainly coloured by the ironized hematoxylin, small spaces, the same size as the granules, from which the stained contents have disappeared.

It seems, therefore, obvious on examining these sections that the mitochondrial substance, which is in direct relation with the secretion of the granules, plays in their fabrication a rôle at least as important as that which Launoy ascribes to the nucleus.

The granules we have seen are situated at the free extremity of the cell, in contact with the cavity of the gland. Gradually they unite with each other and then finally escape, and together

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* Launoy, L., Contribution à l'ètude des phenoménes nucléaires de la secretion (Cellules à venin—Cellules à enzyme). Ann. des Sc. Nat. T. 18 (Zool.), 1903.

with similar granules elaborated by all the other cells constitute that provision of poison which forms into poison-lakes.

IV.—*Physiology.*

The poison, secreted in the deepest part of the gland, is a very dense and syrupy liquid which, if it is deadly poisonous, would be extremely difficult to inject into a person by the agency of the poison-fang. It is, therefore, indispensable, at the moment of biting, that the poison should be diluted so as to render it more fluid, and consequently more injectable. This task is relegated to the mucous gland situated around the excretory duct. The mucous secretion when poured into the canal liquefies the poison situated in the forepart of the poison-gland (properly speaking). The latter is replaced by the poison of the lakes which is used for the later biting. The powerful muscle which surrounds the gland mechanically aids in the propelling of the diluted poison, which thus passes into the wound made by the poison-fang.

To sum up, we see that the poison is present in two distinct phases :—

(1) It is produced as a secretion of the glandular cells and is retained in the reservoirs as a syrupy liquid.

(2) When the poison is to be utilized a liquefaction of this syrupy substance is effected so that it flows more easily from the gland and penetrates more easily into the bite.

It is, in one word, a physiological device by which a snake is enabled to keep in a small space a large quantity of poison necessary both for its defence and for its alimentation.

Explanation of Plates.

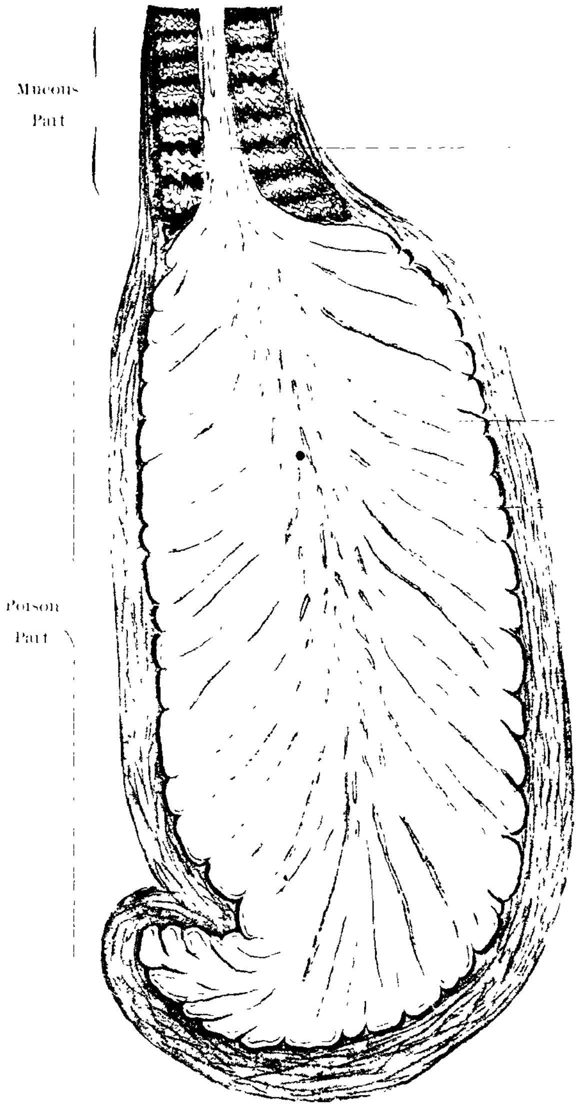
Plate III., Fig. 1.—Section of the whole length of poison gland. × 30.

(Fixation: Bi-iodide of mercury and formalin stained with Hematoxylin-eosin.)

Plate IV., Fig. 2.—Section of parts of four poison lakes with their glandular epithelium. × 100. (Stained with Ironized-hematoxylin.)

Fig. 3.—Five glandular cells showing the elaboration of poison by cytoplasmic and mitochondrial substances. × 1,100. (Fixation: Regaud's liquid.)

a = duct.	*e* = poison granules.
b = poison lake.	*f* = mitochondrial substance.
c = glandular epithelium.	*g* = nucleus.
d = fibrous capsule.	*h* = connective tissue.

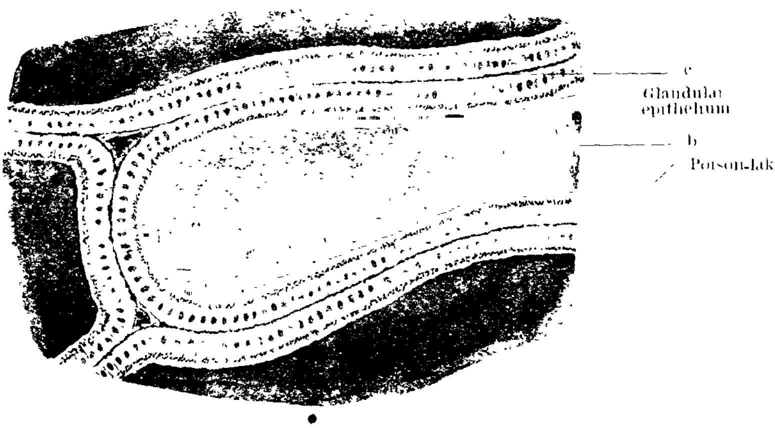


Magnified 30 times

Fig 1 Section of the whole length of poison gland showing the microscopical anatomy × 30

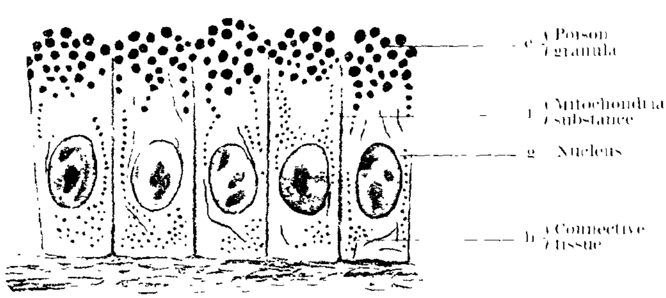
Fixation. Bi-iodide of Mercury and Formalins.

Coloration. Hematoxylin-Eosin



Magnified 100 times

Fig 2 Section from 4 poison-lakes with their glandular epithelium × 100



Magnified 400 times

Fig 3 5 Glandular-cells showing the elaboration of poison by cytoplasmic and mitochondrial substance × 400

Fixation Regaud's liquid

NOTES ON THE EGGS, NESTS, AND BREEDING SEASONS OF SOME CEYLON BIRDS.

By W. E. Wait, M.A.*

At the last meeting of our Society, Mr. Green gave us a most suggestive Paper indicating the lines on which we should work, with some hints of the many problems which awaited solution in all the branches of our fauna, even in those in which most research had been accomplished.

This evening, I wish to follow up Mr. Green's suggestion as regards one particular subject by giving some notes based on my collection of birds' eggs. They will only serve to show how much remains to be done before our knowledge of the nesting and breeding of birds in Ceylon can be said even to approach completion.

Thirty years ago Legge, in his magnificent volume on the "Birds of Ceylon," worked out the occurrence and distribution of our Avifauna so thoroughly that not more than a dozen new species have been added since his time; and most of these additions are mere chance visitors. Legge, however, himself admits in his introduction how incomplete was his knowledge concerning the nidification of many of the species. Again and again, in his description of resident species, he states that the nest and eggs had not yet been discovered in the Island.

In his day, among our Ceylon Ornithologists, there were several keen egg-collectors to whom he often refers. I may mention the names of Mr. McVicar of the Survey Department, Mr. Bligh of Haputale, and Mr. Parker, late of the Irrigation Department. The last-named wrote a Paper giving an account of many Ceylon eggs in one of the parts of "Stray Feathers." He corresponded with Hume and Legge, and I believe he has a magnificent collection of Ceylon eggs. I can only hope that when he has finished his book on Ceylonese folk-lore he will give us a volume on Ceylon Oology. It is badly needed, as since Legge's time practically nothing on the subject has appeared in print easily accessible to readers in the Island.

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* Read before the Ceylon Natural History Society, December 17, 1912.

I have no doubt that there are keen egg-collectors now, but one hears little of them or of their discoveries. If they will send their notes to " Spolia Zeylanica " or to this Society there is no reason why our information on Ceylon nests and eggs should not be as full and complete as the material collected by Hume in his " Nests and Eggs of Indian Birds," to which material Ceylon has contributed far less than its proper share.

There are a number of birds—some of them peculiar to the Island—which are known or suspected to be resident species, but of whose nidification in Ceylon we have no satisfactory account. Let me give a few instances within my own experience. In his description of the Black Bittern (*Dupetor flavicollis*), one of the rarest of the family, Legge states that he had come across the bird during the south-west monsoon at Minneriya in the North-Central Province, and suspected that it bred in the Island. I do not think that the bird is as rare in Ceylon as is generally supposed. I have met with it at least a dozen times while wading round the edges of some of the larger village tanks in the North-Central Province ; and this year I was fortunate enough to find it breeding.

In April I was prowling round the edge of Topawewa, when I flushed a specimen out of a low thorn tree which stood in the shallow water, and found the nest placed in the branches about 5 feet above the surface of the tank. Like most herons' nests it was a shallow saucer of twigs, and measured about 10 inches in diameter. There were two fresh eggs, of a pale sea green, without a trace of the blue tinge which characterizes freshly taken eggs of the Pond Heron (*Ardeola grayi*). The delicacy of the colour soon died away after the eggs had been blown. In shape they are almost oval, there being little difference between the small and large ends. They measure 1·54 × 1·17 and 1·50 × 1·16 inches respectively. A fortnight later, early in May, about 15 miles south-west of Anuradhapura, I was again wading on the edge of a jungle tank when I came round a bush and surprised another Black Bittern busy on a nearly-finished nest. This nest was of very much the same description as the former, but it had in it a spray of nearly fresh green leaves, and was only about 2 feet above the water.

Again I am pretty certain that several of the rarer water-rails will eventually be found nesting in Ceylon. Legge mentions the fact that two eggs said to belong to the Ruddy Rail (*Amaurornis fuscus*) had been taken near Chilaw. He was, however, rather dubious about the find. There are several unidentified eggs in the Museum collection which undoubtedly belong to some species of rail, and I rather think that I have a clutch of the eggs of *Prozana pusilla*—the Eastern Baillon's Crake—in my own collection. Unfortunately they were brought to me by a young villager in the North-Central Province, and I did not see the bird myself.

I had asked the lad to try and get me some eggs of the Tank Pheasant (*Hydrophasianus chirurgus*), a bird which lays four unspotted, bronze-coloured, peg-top shaped eggs, generally on the floating leaves of the water-lily. Next morning he turned up with seven eggs. They were considerably smaller than those of the Tank Pheasant: the ground colour was a rather glossy olive-brown, and they were fairly plentifully sprinkled with dark brown specks. I at first thought they were the eggs of the Blue-breasted Quail (*Excalfactoria chinensis*), and questioned the boy about the finding of the nest. He assured me that he had taken the eggs from a small nest floating on the water some distance from the shore. I went to the tank with him next morning and he showed me a small nest attached to the floating stems of a water-grass. It was a pad of grass leaves, about 5 inches in diameter and 2 inches thick, for all the world like the pad of straw which coolies sometimes put on their heads when carrying loads. The upper surface was slightly hollowed and lined with the fine rootlets of some water-plant. There were seven little depressions in the soft lining showing where the seven eggs brought to me undoubtedly had lain. The spot was about thirty yards from the shore, and the water nearly knee-deep. The tank had been at that level for several weeks, and the eggs were nearly fresh, so that the nest could not have been built when the ground was dry, to be floated up as the water rose. No Quail in its senses would have chosen such a situation, and, besides, the Blue-breasted Quail does not generally lay seven eggs but five or six.

When I got back to Colombo I compared the eggs with the Quail's eggs in my possession. They are distinctly glossier than the eggs of *Excalfactoria chinensis*, slightly larger and not so stumpy or pointed at the small end. The average of their measurements was about 1·07 × ·88 of an inch. Hunting through " Legge " and Hume's " Nests and Eggs " for a solution of the conundrum, I found that they may possibly be those of *Porzana pusilla*, but I shall have to wait until I can find another nest myself, or authenticate these eggs at the British Museum, before I can be certain of the find.

To take a third example. There is little definitely known about the nidification of one of the commonest of the species peculiar to Ceylon, the Brown-capped Quaker Thrush (*Pellorneum fuscicapillum*). One may hear him any day in the jungles of the North-Central Province singing away like a street boy, whistling up and down the scale out of tune, and if you watch closely you may see him hopping about on the ground among the undergrowth—a little olive-brown fellow with a chocolate-brown cap and a lighter-brown under plumage.

He belongs to a genus of which there are seven Indian species. Oates, in the " Fauna of British India," remarks of the genus that " their nests are domed and built on the ground with one doubtful exception." That exception is our little Ceylon representative. Legge records that Mr. Bligh found the nest at Haputale. " It was placed in a bramble about 3 feet from the ground, and was cup shaped, loosely constructed of moss and leaves : it contained three young." Later on, in the appendix, he states that Mr. Parker had sent him an egg which is illustrated in the plate at the end of the volume. Unfortunately he gives no description of the nest or of the situation in which it was found, and the illustration of the egg is not very satisfactory. It is represented as of a whitey-brown ground colour, with red-brown spots which form a cap at the larger end, and some purple spots.

Soon after I started collecting, a cooly brought me two eggs somewhat answering to this description, which he said he had found in a nest on the ground under a bush. This was at Katuwana in the Southern Province in March, 1907. A year

later Mr. John Still brought me two precisely similar eggs, which he and Mr. J. G. Fraser had discovered while going through the forest in the North-Central Province. The nest lay at the foot of a tree ; it was cup-shaped, composed of grass and dry leaves, and measured about 4 inches across. They described the bird, which they saw fly off the nest, as stout, of a dark brown colour, and somewhat resembling a Quail. There are two more eggs of the same sort among the unidentified specimens in the Museum collection. I hope that they may eventually be identified as the eggs of our Ceylon Quaker Thrush.

The examples I have just given are but three out of many species, of whose nidification we require information, and any collector may at any time come across a coveted find. But apart from new finds, there are always fresh facts and little—perhaps local—peculiarities to be noted about birds whose nesting habits are already recorded.

Osmotreron bicincta—the Orange-breasted Green Pigeon—is one of our two common green pigeons, and may be found in flocks in many parts of the Island. It is equally common in many Indian districts. Legge records little or nothing about its nidification, and the notes on the subject in Hume's "Nests and Eggs" are not very full. I have found its nest half-a-dozen times in the North-Central Province. The usual breeding season is in April and May, but this year I took a nest in August with two fresh eggs. It is a mere apology of a structure : half-a-dozen twigs just sufficiently meshed together to keep the two eggs from falling through. The eggs are of the usual pigeon type, pure white, and almost perfectly oval, with a moderate gloss. The average size is 1·07 × ·88 of an inch.

There are, however, several constant and noteworthy features about all the nests which I have come across. The birds, when in flocks, generally frequent the tops of trees, but the nest has invariably been placed about 6 feet from the ground in a thorny small-leaved bush or tree ; it has always been by the side of a path or roads, but never near any habitation, and I have always found the beautiful orange and lilac-breasted male sitting on the eggs. I think the nest often

escapes detection as the bird sits so close that one has almost to bundle it off the eggs, while the tints of the upper plumage harmonize with the colours, in light and shade, of the foliage.

Our other Green Pigeon (*Osmotreron pompadora*) also nests in the North-Central Province. The nest and eggs are precisely similar to those of the last-mentioned species, and could not be told apart, but I have found it building as much as 20 feet up in a tree, and it seems to prefer trees or bushes on the edge of the jungle round tanks.

Another common bird with well-marked breeding peculiarities is the beautiful Paradise Fly-catcher (*Terpsiphone paradisi*). As many of you know, the long-tailed male gradually changes its plumage, the most striking change being that, broadly speaking, the chestnut of the upper plumage and tail turns to pure white. The change is fully completed in the fourth year. Now the young birds breed freely in the North-Central Province, and I have also taken their nests in the Tangalla district. But the males in their third and fourth year would appear to migrate. They are never very common, and I have only once seen a black and white male in the North-Central Province during the south-west monsoon. The nest is a little thin walled cup, about 2½ inches in diameter and 1½ inch deep, built of grass and fibres, unlined inside, and bound round on the outside with cobweb and sometimes small cocoons. I have nearly always found it placed from 6 to 12 feet from the ground, on a downward hanging branch, where a small twig shoots upward to form, more or less, of a fork. The nest is placed in the angle, but is mainly built up from its base on the larger branch. I do not think that I have ever seen a nest in the outer branches. The bird seems to prefer a spot well in the shade, close to the trunk, and as often as not it chooses a leafless branch. The eggs are generally three in number, of a pinky white ground-colour, with reddish brown spots chiefly at the larger end. The average size is ·78 by ·57 of an inch.

So far I have shown how an egg collector may add to our knowledge of the nidification of individual species ; but when one has collected data for a number of species in any one district, one may begin to speculate on a wider and most

fascinating problem, namely, the breeding seasons of the various species in different parts of the Island. Now in Ceylon we have no real summer or winter, and given favourable climatic conditions one may find birds breeding in any month of the year.

In his introduction to "The Birds of Ceylon," Legge gives the main breeding seasons as follows :—"The majority of Ceylon birds breed during the first half of the year, the exact times varying according to locality and climate. In the Western Province the height of the breeding season is, as in India, during the rains of April, May, and June. At this time the jungles teem with insect life, and all forest birds are busy rearing their young. In very moist districts, such as Ratnapura and the Pasdun korale, eggs may be found in August and even September. Among early breeders in the Western Province may be cited the Barbets and Woodpeckers. On the eastern side of the Island many birds commence to breed in November and December, while the heavy rains are falling ; but the season continues, nevertheless, throughout the first three or four months of the year, and many birds may be found nesting as on the western side in May and June. In the hills, and more particularly in the upper ranges, where the nights are cold and frosty in January and February, the nesting season commences at the end of March or beginning of April, and continues until June and July, corresponding in this respect with the breeding-time in temperate climates. In the north of Ceylon, the larger Waders (*Ardeidæ*) and the water-birds that breed with them, commence to nest in November ; but on the south-east coast, the season is later, the heronries not being resorted to as a rule, I think before January."

Within these broad generalizations, my own experience shows that there are a surprising number of variations. Some birds habitually build earlier than others, some birds seem to go on nesting indiscriminately for several months ; and again in some places I have found that certain species have two well-marked nesting times, between which their eggs are not usually to be found. To work out the problem fully we require detailed observations carried out over a

number of years and in every part of the Island. Incidentally, I may mention that the collecting of such material will probably bring out some very interesting facts on the internal migration of certain species from one part of the Island to the other.

As it will be a long time before the full materials can ever be collected, I am going to be rash enough to give you this evening some tentative speculations on the causes which govern the continuance or the variation of the breeding seasons of different species in the same district. These speculations are based on my own collection of eggs, and on my rather fragmentary observations.

I may state at the outset that my collection consists of about 80 species, the majority of which have been taken in the North-Central Province and the Tangalla district of the Southern Province. Accordingly, my remarks must be taken as applying only to these two districts, or at all events, only to the dry low-country zone to which both belong. The rainfall and climatic conditions of the two areas present no marked differences, and I should say that over 90 per cent. of the species of birds inhabiting the one region are to be found in the other.

As I said above we have no real seasonal changes in Ceylon, and the birds breed whenever the climatic conditions are most favourable. At breeding-time birds must have an ample food supply, and what I may term a suitable environment for their nests ; the meaning of the latter phrase will appear more fully as I go along.

Now, any climatic conditions which will give birds these two requirements will induce them to breed in greater or less numbers, and, broadly speaking, these conditions are fulfilled during, or soon after, any period of rain, but the conditions vary for different classes of birds.

In both Tangalla and the North-Central Province the rainy season begins at the change of the south-west to the north-east monsoon, and the rains extend roughly from October to Christmas. There are, more or less, frequent showers from Christmas onwards till the burst of the south-west monsoon, but February, March, and April are often dry, and are

the hottest months of the year. In a normal year very little rain falls during the south-west monsoon, and the country gradually becomes dry and parched.

Now let us see how this rainfall affects the breeding season of the different classes of birds. We will first take the birds which build nests in trees or bushes. Many of them begin to breed as soon as the rains have well begun, and the foliage has become green and thick enough to give them plenty of cover for their nests ; and as they are in no danger of being swamped out they do not mind building in the middle of a wet spell. They will go on breeding intermittently as long as favourable weather continues. The approach of dry weather curtails their nesting ; but if enough rain falls at any unusual time, they will start again. For instance, in 1909 I took the eggs of such birds as the Golden Oriole (*Oriolus melanocephalus*), the Madras Bulbul (*Molpastes hæmorrhous*), the Jungle Wren-warbler (*Prinia sylvatica*), and the Magpie Robin (*Copsychus saularis*) in the North-Central Province in February. I was up there again at the end of April and the beginning of May, when the country was still fairly fresh, and found all these species and many others still laying eggs. In November of the same year, they were again breeding. In April, 1911, I found the drought had already set in and discovered very few eggs. In that year there was a general drought all over the Island, and I got very few eggs anywhere. In May, of this year, the tanks in the North-Central Province were still full, and the country green ; birds were breeding plentifully. Again, last August I struck a small patch of villages about 20 miles north-east of Anuradhapura where some local thunder-storms had freshened up the district, and I discovered the eggs or nestlings of no less than 20 species.

Of course, there are many exceptions which require further explanation. For instance, why do the Crows not breed till June ? But as a broad rule, in the dry zone of the low-country birds which build among branches will nest at any time provided that there has been sufficient rainfall to revive the vegetation and bring out their food supply.

The ground nesters do not begin to breed nearly so early. They have to wait until the heavy rains are over, until the

ground is dry enough for their purpose, and until the weather has become so settled that there is little fear of their being swamped out by a heavy pour. The Night-jars nest from April on to August. The Larks and Pipits for the most part wait until the paddy is reaped, and the water has run off the paddy fields, which are their favourite nesting grounds. The Green Bee-eater (*Merops viridis*) is another good instance. This bird excavates a long tunnel like a Kingfisher's burrow, but instead of choosing a perpendicular bank, it will run its shaft into the least little rise either on suitable bare grassy land or by the side of the road. The tunnel often slopes downwards, and if the bird did not wait till well on in the dry weather, it would often run the risk of being flooded out by a heavy thunder shower.

But the most interesting bird from the point of view of my theory is the common Did-he-do-it (*Sarcogrammus indicus*). Its favourite breeding ground in the North-Central Province is the belt of bare grassy land round every village tank. As soon as the water begins to recede from the rim of jungle which marks spill level the birds will start breeding, generally choosing little bits of rising ground for a nesting site. As long as there is any water in the tank they have an ample feeding-ground, and as the water gradually shrinks in the tank-bed they obtain an unlimited choice of little depressions and hoof marks in the sun-dried mud in which to lay their eggs. And so you may find the eggs any month from April to September, for during the whole of that time the birds have a good food supply and a suitable nesting environment.

Lastly, let us take the waders and swamp-nesters, which are found in numbers on the tanks of the North-Central Province and on the lagoons of the Tangalla district. The Heron family generally nest in trees, and as we might expect they are early breeders, choosing a time when their feeding areas—the swamps and tanks—are at their fullest. Birds which build close to the water's edge in reeds or grass have to wait until the rains are over, and there is no danger of the water rising and flooding their nests. For instance, in the Tangalla district, the Blue Coot (*Porphyrio poliocephalus*), the Moor-hen (*Gallinula chloropus*), and the Clamorous Reed-warbler

(*Acrocephalus stentorious*) nest in March, when the weather has become settled.

Some aquatic birds, such as the Whistling Teal (*Dendrocygna javanica*), and the White-breasted Moor-hen (*Amaurornis phœnicurus*) build either in trees, or in the long grass and rushes of swamps. In the North-Central Province the Teal breed mostly in the hollow forks of the large kumbuk trees which grow round every village tank, and they nest soon after Christmas. I once found a nest in the long grass near a swamp in the Tangalla district. That was in the month of July, very late in the season. On the other hand, I have generally found the White-breasted Moor-hen (*Amaurornis phœnicurus*) breeding from May to August and constructing a weed-nest among the rushes ; but I once found the bird breeding in November soon after the rains had begun. On that occasion the nest was a huge saucer-shaped affair of twigs placed in a bush several feet above the spill level of the tank. So it would seem that birds which nest either in trees or among rushes will begin to breed early on in the season if they choose trees, but if they nest in a swamp they wait until it is safe for them to do so.

Birds too will suit their breeding seasons to modifications such as those caused by irrigation schemes. The lagoons between Ranna and Ambalantota used to be mere salt pans. Now they receive all the tail-water from several thousand acres of paddy land irrigated by the Udakiriwila and Walawe schemes. These paddy fields come right down to the edge of the lagoons, which are now almost fresh water swamps. There are two harvests of paddy in the year, roughly in March and July. As the paddy ripens, the food supply, both of insects and grain, is very abundant, and the swamps are fairly full of the tail-water. So it is not surprising to find that many birds, which normally have only one brood here, nest regularly twice in the year. I can always discover the eggs of the Purple Coot (*Porphyrio poliocephalus*), the Moor-hen (*Gallinula chloropus*), and of the Clamorous Reed-warbler (*Acrocephalus stentorius*) both in March and July. In the heronries on the lagoons the Herons and Cormorants also breed twice a year, but a little earlier.

As regards birds which nest in holes in trees, I have not as yet very much to offer in the way of conjecture. Legge, in the passage which I quoted above, stated that both Barbets and Woodpeckers were early breeders in the Western Province, but that is not my experience in the North-Central Province. There the Barbets, which are fruit-eaters, breed early and appear to have several broods in the season. The Woodpeckers, insect-feeders, breed fairly late, and appear to have only one brood. Quite possibly the food supply of the Woodpeckers becomes abundant only late in the season.

Personally, I know practically nothing about the breeding season in the wet zone and up-country, and I should very much like to know whether there too the different species breed at different times of the year, and whether the differences can be traced to the same causes which I have endeavoured to explain as influencing the nesting seasons in those parts of the Island with which I am more familiar.

We want notes and observations taken in all parts of Ceylon, and in the hope of inducing some more naturalists to take up this branch of ornithology I should like to conclude my Paper with some hints on the finding of nests and the collection of eggs.

Often when I have been showing my eggs people have remarked " But where do you find them ? " " I used to collect eggs when I was a boy, and I have been in the jungle a good bit, but I seldom come across any nests."

I think there is something in what they say. Out here, birds have many more enemies to guard against than at home, and the nesting area available is so much larger that nests are not so easily spotted.

Instead of the obvious hedge-row and the comparatively limited copse or wood, there is limitless jungle. However, one gradually learns how and where to look, and the process of learning is a splendid training for the powers of observation.

Nearly all birds give their nests away by their behaviour ; and one learns to watch for the signs by which they do this. A good many sitting birds wait until one is quite close, and then start off in such a flurried way that they betray them selves. If a Bulbul or Cinnamon Thrush bolts out of a bush

as you walk up, or a Quail explodes from right under your feet, you may very probably find that there is a nest. In the same way look for a nest-hole if a Mynah or Woodpecker suddenly flies away from half way up a bare tree trunk; and if you see a Golden Oriole dart out from the end of a low-hanging branch, examine the spot carefully.

I have twice got the eggs of the little Wood-shrike (*Tephrodornis pondicerianus*) from noting how the bird flew away from the upper surface of a horizontal bough. The nest is a shallow saucer, glued on to the surface of the bough, and so felted with cobweb and lichen that, from the ground, it appears a mere roughness of the bark ; and unless the bird showed you the place you would scarcely ever be able to see that there was a nest there.

Some birds get very restless—hopping about the branches and twittering while anyone is close to the nest.

On the other hand, the Red-wattled Lapwing, which is usually such a shrieking nuisance, gets off her eggs without a sound at fifteen or twenty yards range and hurries off in a most amusingly quiet and furtive manner.

Again, follow up any bird you see flying off with a long straw, a twig, or feather in its mouth ; or if you see a small bird fly out in a fury and drive away a larger intruder watch carefully the branch to which it returns. I found my first nest of the Bush Bulbul (*Aegithina tiphia*) in this way. The little cock-bird darted from a thin branch and fairly hustled out of the neighbourhood a Cinnamon Thrush which was casually wandering by.

After finding one or two nests of a species, one soon gets to know the likely localities in which to look, and as nesting lore is gradually acquired far less time is spent in poking around aimlessly.

But before taking up bird-nesting in Ceylon one should have a working acquaintance with, at any rate, the commoner birds of the field and jungle, for this reason—that one must, wherever possible, identify beyond doubt the bird to which the nest belongs. Many of our Ceylon eggs are, by themselves, indistinguishable from the eggs of other species. For example, one might easily confuse those of the little Kingfisher

(*Alcedo ispida*), with those of the Green Bee-eater (*Merops viridis*). The eggs of our two Green Pigeons cannot be told apart, and I should be very sorry to have to name correctly any egg of our half-dozen species of Munia, unless I had seen the bird and the situation of the nest.

Eggs named and brought by villagers should be accepted with the greatest caution. There are specific native names for most of the birds, but as often as not they are incorrectly used. I have heard the term Lihiniya applied to the Hill Mynah (*Eulabes religiosa*), the Wood Swallow-shrike (*Artamus fuscus*), and to various species of Swift and Swallow; while Pandarella has stood equally well for Larks, Pipits, and Quaker-thrushes. They will also put a Sparrow's egg in a Bulbul's nest and gravely swear they have brought the nest and eggs of a Fly-catcher.

When unknown eggs are brought by villagers a book like Hume's "Nests and Eggs" is of great value in provisionally identifying the specimens, but you should not be satisfied with the correctness of such an identification until you have verified it by discovering similar eggs yourself and seeing the bird off the nest. A villager in the North-Central Province once brought me two white eggs, which he stoutly maintained were those of the Bronze-wing Pigeon (*Chalcophaps indica*). He described the nest as having consisted of a few twigs placed not very high up in the branches of a tree. The eggs were certainly white, but they were of a chalky texture and resembled miniature specimens of the egg of the Crow Pheasant (*Centropus sinensis*). I had my suspicions, but it was not till three years later that, in November last, I flushed a Green-billed Malkoha (*Rhopodytes viridirostris*) off a slight nest of sticks placed in the branch of an Euphorbia tree, and found a chalky white egg, the exact counterpart of the two eggs brought to me by the villager. As I told you at the beginning of my Paper, I am still waiting to verify what I take to be the eggs of the Ceylon Quaker Thrush (*Pellorneum fuscicapillum*) and of the Eastern Baillon's Crake (*Porzana pusilla*).

Lastly, always keep a record of the date and locality of any nests found, and mark your eggs so that they can at any time be referred to the record. My own eggs are always marked,

close to the hole by which they were blown, by a number and a letter. The number denotes the species and the letter corresponds to a lettered entry on the page of my loose leaf catalogue allotted to that species. Thus, my eggs of the Indian Tailor-bird (*Orthotomus sutorius*) are marked " 14." Specimens marked A 14 were taken in June, 1907, in the Medagama pattu, Province of Uva, and those marked C 14 at Kendewa in the North-Central Province in May, 1911.

Without such a record a collection of eggs loses most of its scientific value, and if unmarked eggs once get mixed they are soon confused past all sorting. I am afraid that this has been the fate of a fine collection of eggs which used to belong to Mr. Hine-Haycock, and which is now in the Museum. I believe that there is no trustworthy record of where or when many of the eggs were obtained. They were collected from many sources, and some specimens labelled as belonging to very rare species are in reality common varieties masquerading as the eggs of more valuable birds. Furthermore, beyond all doubt the labels have been transposed in many cases, and, as there are no marks to identify the eggs, what would have been an exceedingly interesting addition to the Museum collection, has become, to a certain extent, a confused lot of Oological specimens.

SOME NOTES ON BUTTERFLIES AND THEIR DISTRIBUTION.

By F. M. MACKWOOD

OCCASIONALLY I am asked to name an amateur's collection, and when I set aside some as moths, the question is put : What is the difference between a moth and a butterfly ? These two form the group of insects known as " Lepidoptera," divided as *Rhopalocera* and *Heterocera.*

Rhopalocera (butterflies) means club horned, viz., that the end of the antennæ is club-shaped. *Heterocera* (moths) various horned or antennæ of various shapes. Moths have a thicker body, at its junction with the thorax of same diameter ; that of the butterfly is slender and wasp-shaped.

They vary in habits. The butterfly is a day-flier and at rest folds its wings vertically over its body. Moths fly after sunset and expand their wings horizontally when resting.

The origin of the word butterfly is unknown. Derived apparently from an Anglo-Saxon root, it is thought to have been given to a species of yellowish colour.

Soon after beginning to collect, the need of works of reference will be felt by the student,* so that the captures can be classified and named ; later on, most collectors will want to know how the insects of their locality and country compare with neighbouring ones.

Rhopalocera (butterflies) are divided into six groups or families, viz., *Nymphalidæ*, *Nemeobidæ*, *Papilionidæ*, *Pieridæ*, *Lycœnidæ*, and *Hesperidæ.* The first named is the largest group ; all of them have sub-families.

In entomology, as with all other branches of natural history, there are two sets of writers, the one a species-maker or " splitter " giving specific rank for every variation often inconstant. The other, known as a " slumper," grouping as many as possible under one name.

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* Read before the Ceylon Natural History Society, February 28, 1913.

The Ceylon works of reference available to a student are :—

1. " Sir Emerson Tennant's Ceylon," published in 1859. The list of butterflies therein given numbers 172 species, mostly from the collections of Dr. Templeton and Mr. E. L. Layard. The list is now of little use, many of the species not being traceable, and others being purely Indian. It is, however, of interest in that it records 69 *Nymphalidæ*, 17 *Papilionidæ*, and 27 *Pieridæ*, against 69, 15, and 28 respectively existing at present.

2. In 1880–81 the first volume of Moore's " Lepidoptera of Ceylon " was issued, followed at intervals by the second and third. In this 250 species are described, and the larger number figured. Mr. Moore was a splitter, and 40 of his 250 species can be eliminated ; the materials for Mr. Moore's work were furnished by Dr. Thwaites, Capt. Wade Dalton, Capt. Hutchison, Mr. E. E. Green, and myself. The three volumes are expensive.

3. In 1889 an up-to-date and compact " list of the butterflies of Ceylon" was issued by Mr. de Niceville and Major Manders, R.A.M.C. The notes to the various species are very serviceable. 228 species are enumerated ; 5 or 6 of these are now regarded as varieties only, and a few more species, since discovered or then overlooked, must be added.

Indian works of reference, including Ceylon, are :—

1. " The Butterflies of India, Burma, and Ceylon," by Marshall and de Niceville, Vol. I., appeared in 1882. Vols. II. and III. at intervals later. I think this the most interesting of any of the Indian reference works from its wealth of notes. Unfortunately through Mr. de Niceville's death, the much wanted Vol. IV. was never issued : it would have dealt with the *Hesperidæ*, the most difficult family of the *Lepidoptera* to describe.

2. In 1905 the Government of India through the British Museum, under the title of " The Fauna of British India including Ceylon and Burma," issued the first volume, and in 1897 the second volume. The editor was Col. C. T. Bingham, who, unfortunately, died before finishing the third volume, which would have completed the *Lycœnidæ* and dealt with the *Hesperidæ*. As an author, Col. Bingham was a slumper—

perhaps too much so in several instances. The remaining volumes to complete the Fauna of British India are being edited by Mr. H. Druce, and we hope may be issued soon.

3. In 1890 Moore issued his Vol. I. of "Lepidoptera Indica," a magnificent and costly work, in which every species is figured. Mr. Moore died before the work was finished, which I believe is being completed by Col. Swinhoe.

4. A very useful "List of Indian Butterflies," published by the Bombay Natural History Society in 1912, Parts II. and III., edited by Capt. W. H. Evans, R. E., range of locality is given, as well as every race or sub-species, with numerous serviceable notes. The two Papers can be separately bought; bound together they form a handy volume invaluable for reference.

Having finished with the works of reference, I now come to the Ceylon butterflies themselves. These are put at 226 to 228 species. The great majority of these are also found in South India, 42 of the number are peculiar to Ceylon as being distinct species or sub-species, but very doubtfully so; a slumper would reject half; personally I think 30 species only are distinctly Ceylonese and these include nearly all the rarities.

In distribution, the foot hills up to 3,000 feet show the largest variety; at 4,000 feet upward 7 species appear; in the dry zone and never above 500 feet elevation about 20 species are found, including all the "Colotis" group, popularly known as "orange tips," and several *Lycœnidæ* and *Hesperidæ*. In the bamboo jungles of the Southern and Sabaragamuwa Provinces and in lesser degree in the Western Province are to be found the scarce *Satyrinæ* and *Discophora lepida*, about 30 species are found everywhere from Colombo to Jaffna or Nuwara Eliya, even at the top of Pedru. One butterfly discovered a few years ago in the Nitre Cave country, and named "*Atella ceylonica*," has a very restricted range; so far it is found only in a valley about six miles by three, varying in elevation 1,000 to 2,500 feet.

The best and longest worked centre is Kandy, with a radius of ten to twelve miles. I have records of 178 species captured—one species, "*Elymnias singhala*," used to be confined to this area, but is now extending elsewhere.

Colombo district; before tea and rubber had taken the place of jungle and chena in the outlying portions, used to give a fair number of species, and I have records of 138 species, nothing remarkable as to rarity. *Danais exprompta* and *Euplœa core*, then restricted as to area, are now more widely diffused. Occasionally, a fair number of *Iraota timoleon var. nicevillei* are obtained.

The Puttalam district and around Hambantota has been well worked by Mr. Pole, and Haldummulla-Wellawaya country by Mr. Ormiston, who has obtained numerous interesting species and varieties from the locality.

Mr. C. C. Gilbert, resident in Ratnapura District, has in about two years, and that within a limited area, achieved such success that probably as a centre, even for numbers, it will take precedence of Kandy.

As to quality, it has already done so, for out of about 167 species netted, there are many rarities. In all probability 20 more species may be obtained. In various parts of the Province *Mycalesis rama*, *Rapala melampus* and *Halpe egena* have been found.

The vicinities of Nuwara Eliya, Anuradhapura, and Trincomalee have been fairly well worked, but most of the Northern and Eastern Provinces, the Batticaloa-Hambantota country inland, and the Ratnapura-Rakwana-Tangalla country have scarcely been touched, these, formerly almost inaccessible, can now be reached by motor car.

Butterflies, whilst fairly numerous in Ceylon, are rarely abundant except of the common species, or during the migratory flights. When one goes out for any particular kind, he may be considered lucky to get half-a-dozen good representatives. Occasionally great multitudes are met with. In December, 1911, at Anuradhapura, on the herbage on the margins of Tissa Tank, for two or three days in succession, there were literally hundreds of thousands, mostly of large and showy common species, a good sprinkling of others, and here and there a scarcer form ; it would have been easy to catch twenty or thirty specimens at each sweep of the net.

Compared with Indian butterflies, I think ours, as a whole, are a more sombre lot, even in the "*Lycænidæ*," the ever

popular " blues," we show relative poverty of colour, but in number of species, considering our area, we compare favourably.

In Evans' list for India and Burma, with an area of 1,900,000 square miles, there are recorded 1,048 species and 423 sub-species or races, against Ceylon 226 species and 3 sub-species for 20,000 square miles. South India, eight or nine times our area, shows only about one-third more species in its favour.

In conclusion, I would point out that it would be a mistake to think there is such uniformity amongst butterflies, that once the requisite number of males and females have been pinned into the cabinet and labelled, they are done with ; it is not so ; in large numbers of species there are numerous varieties, frequent aberrations, some of them of extraordinary character ; then there are species with dimorphic and polymorphic females, and numerous others which show considerable difference between their wet and dry season forms. A good deal of work has yet to be done in breeding larvæ to solve the position of some butterflies as to specific rank or variety ; altogether it will be years before the Ceylon collector and student of Ceylon butterflies can say " Finished," which, however, I must say as regards these notes.

NOTES.

1. *Some Pioneers of Natural History in Ceylon.*—I should not have omitted the name of Jacob Burnand, an "Oppercoopman," or, to give this title its English equivalent, a "Senior Merchant" in the Dutch East India Company's service, whose name was, in Bennett's time, "deservedly remembered" in Ceylon, "for he was distinguished both by his zeal for the welfare of the Island through the introduction of the culture of valuable exotics from the Malay Peninsula and the Dutch Islands of Java, Banda, and Amboyna, and by his botanical acquirements." (*Ceylon and its Capabilities*, p. 218.) A Swiss by birth, he arrived in Ceylon in 1778; was Chief of the Batticaloa District, and subsequently Desawa of Jaffna, and died on March 3, 1816, at Colombo. He wrote for Governor Sir Thomas Maitland in 1809, a memoir on the "Ancient and Modern State of the Island of Ceylon and its Agriculture, &c.," which Sir Alexander Johnston thought so highly of that he made a translation of it for Lord Londonderry, then Secretary of State for the Colonies. The translation is published in the *Monthly Literary Register*, Vols. III. and IV. (1895–6).

I think, too, that of the British period, Joseph Jonville and Major-General Hay Macdowall deserve some notice. Jonville was the first Superintendent of the Botanical Garden started by Governor North, first at Peliagoda or "Ortafoula," and later, owing to Jonville's condemnation of the first site, at Slave Island ("Kew"). Of him Viscount Valentia remarked :—"Mr. Jonville, a Frenchman, is possessed of considerable talents, and very great knowledge of several branches of natural history." (*Voyages and Travels*, p. 316.) In April, 1801, he wrote a "Report on the Pearl Fisheries in the time of the Dutch and of the British." He arrived at the end of 1798, or beginning of 1799, but left within four or five years, having held, besides his first appointment, those of

" Chief of the Cinnamon Plantations," Surveyor-General, and " Commissioner Extraordinary of Government in the Province of Seven Korales."

Of General Macdowall it may be said that he was more successful as a botanist or gardener than a soldier. Cordiner states that, " by the friendly care and persevering attention of Dr. Roxburgh, Superintendent of the Company's botanical garden at Calcutta, General Macdowall was enabled to make a valuable collection of exotics, which he left in his garden at Colombo in February, 1804," when he left Ceylon. " During his residence at Colombo, he was in the habit of receiving boxes of trees and shrubs by almost every ship : and one acre and a half of ground was completely filled with them, ranged at proper distances." Cordiner mentions among these the following plants, " not one " of which " had ever been brought into the Island previous to the General's arrival ":—

Peaches, grafted and trained on espaliers, which in May, 1805, " promised an abundant crop."

Apples, which " thrive remarkably well on espaliers," but had not yet borne fruit.

Loquats, *lechées*, and *wampees*, all " China trees."

Melicocca or *genip* of the West Indies, which " thrives remarkably well."

Mangosteen or *garcinia*, nutmeg, clove, *pimento*, *sapota*, or *achras*, star apple or *chrysophyllum*, all " growing in high health and vigour."

Asparagus, which " succeeded remarkably well."

The General anticipated the aims of the Agricultural Society, for he likewise " took pains to set " the natives " an example of gardening," and on his departure left directions with his nephew, John Macdowall of the Civil Service, with regard to the numerous exotic plants in his garden, " to give a few of each sort to every person who promised to nourish them." It had been " his wish and design to have introduced a large quantity of the spice plants, such as nutmegs and cloves, but the scheme did not obtain the approbation of Government."

Yes, General Macdowall, introducer of the mangosteen, deserves to be included among the pioneers of natural history of the Island.

His house, it may be mentioned, was at Grand Pass— " a country seat built by the late Dutch Governor van Anglebeek." Are any of the trees planted by him or any of their descendants still to be found on its site ? (Cordiner, Vol. I., pp. 386, 46.)

Quisisana, Walton by Clevedon, J. P. LEWIS.
February 5, 1913.

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2. *Fight between Snake and Mungoose.*—At dinner in the evening I was witness of an exciting fight between a small but venomous snake which fell from the roof, and Mr. Denham's tame mungoose which fortunately happened to be in the house. The fight lasted half an hour, the mungoose circling round the snake, which, sitting up in a sort of figure of eight coil, made repeated darts at the mungoose, but only succeeded in striking the coconut matting each time, lashing its tail from side to side. The mungoose kept moving its head quickly from side to side, a sort of feint apparently to avoid the snake's blows, and as it circled round the snake, the latter moved its head round so as never to take its eye off the mungoose, or let the mungoose get at it from behind. At the end of 10 minutes or so, the mungoose got in under the snake's guard and caught it by the back of the neck, but it did not, as it easily might have done, kill it. Apparently from sheer love of the fight it wanted to have some more rounds, for it dropped the snake which immediately tried to get away. The mungoose followed it, but was very careful not to catch it by the tail. All through during the actual fight it treated the snake with great respect, from which circumstance, and from the " spade " shape of the snake's head, I concluded that it was a poisonous one.

The second and third rounds were simply a repetition of the first, and ended in the same sort of by-play in the intervals. The snake seemed exhausted and could only just come up to time, the mungoose was always quite fresh. Finally, the mungoose seized the snake for the third or fourth time by the back of the neck, and, deciding to end the matter, gave it two or three vigorous shakes, as a terrier shakes a rat. This

treatment soon killed it. This small quadruped then proceeded to eat the snake as if it was a carrot, crunching it up bit by bit and ending with the tail which, sticking straight out of the mungoose's mouth, slowly and gradually disappeared. Not a particle of the snake was left, and the mungoose metaphorically, if not actually, smacked its lips.

I noticed that when the snake was not coiled, the mungoose thrust its nose right up to the snake's mouth as if it were a member of the Ceylon Natural History Society and was very much interested in studying the conformation of its fangs. But as soon as the snake was coiled it took care to keep out of reach.

[From my description of the snake, Mr. William Ferguson, of the Irrigation Department, told me two or three days later at Vavuniya that it was probably a pit viper, "*Echis carinata*," which is very poisonous, if not deadly.]

Marichchukaddi,
November 27, 1904. J. P. LEWIS.

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3. *A Lunar Rainbow at Sea, &c.*—This evening there was a very beautiful lunar rainbow. Its span was about 60° and the greatest height of the arch about 12° above the horizon. The moon at the time was shining clearly in a patch of cloudless sky surrounded by rain clouds. It bore E. by N. and the rainbow W. by S. The western sky was full of rain showers and there was a slight rain falling at the time. Three colours were plainly visible in the bow: (1) on top a red-yellow, red being most prominent, (2) middle, orange-yellow, (3) bottom, a pale blue. The whole space below the bow and enclosed by it appeared to be slightly illuminated and the sky above was black. The bow remained plainly visible from 6.20 to 6.35, when it disappeared amid flashes of lightning. It was the best lunar rainbow I have seen.

From the reports of the lightkeepers at both the Great and Little Basses it appears that, generally speaking, the rain which has been falling in Ceylon so abundantly during the last weeks has seldom reached the lighthouses. They see it

constantly falling over the mainland but only get slight drizzles. That was the case this evening. It rained heavily over the land.

GREGORY STAPLETON.

ss. " Ceylon," off Littlé Basses Lighthouse,
November 24, 1912.

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4. *A " Thunderbolt " near Colombo.*—On April 3, 1912, I went to Jaffna from Colombo by the ss. " Lady McCallum." Soon after leaving Colombo we ran into a severe thunderstorm at about 5 P.M. During the course of the storm a severe crash was heard and at the same moment I saw, less than half a mile away, a vivid red flash pass downwards into the water followed by a hissing sound and a splash. Immediately afterwards a column of steam arose to a height of about 20 feet. I attribute this phenomenon to the presence of a meteorite. Whether the crash I heard was due to thunder or to the approach of the " thunderbolt " I am not able to say. The red flash, which was in marked contrast to the bluish-white lightning flashes, was evidently caused by the descent of an incandescent body. This would account for the hissing noise as the body plunged into the water and for the column of steam which was seen immediately afterwards.

Colombo Museum, JOSEPH PEARSON.
February 25, 1913.

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5. *Note on the Occurrence of Melanitis ismene (Cramer) at Sea.*—On October 24 last, a specimen of this butterfly was captured on board the ss. " Oxfordshire," of the Bibby Line, while crossing the Arabian sea, on her maiden voyage to Colombo, the ship at the time being over 600 miles from Minikoi. The butterfly, which was still active at the time of capture, belonged to the so-called wet-season form of *Melanitis ismene.* As gentle head winds had been encountered for some time before, it seems probable that the specimen had been

carried from the Indian or Ceylon coast, but as *Melanitis ismene* also occurs in Africa, the possibility that it came on board when the ship was passing Cape Guardafui, or the Island of Socotra, must also be considered. It seems tolerably certain, however, that if the butterfly hailed from Africa it would have been seen several days earlier, and the facts, therefore, seem to justify the assumption that it had an Asiatic origin.

December 18, 1912. J. R. HENDERSON.

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6. *A Note on the Occurrence of " Parus atriceps " (the Grey back Titmouse in Colombo).*—In Mr. W. A. Cave's Paper on the " Birds of Colombo," he included, I understand upon my statements, the above bird, *Parus atriceps* in his list, and the inclusion led to a certain amount of criticism. So that I consider it expedient to put on record the fact that this bird, though rare in Colombo, certainly does occur there. As I write now, in my office near the Medical College, I can hear a pair of them making a great fuss outside the window, not thirty yards from my chair.

The bird is perfectly familiar to me from my observation of it at intervals for the last four years in Nuwara Eliya. I have observed it there at all seasons of the year and have found its nest. So far as Colombo is concerned, I first noticed the bird in June, 1911, in the Government Training College compound. At that time I saw the bird for several minutes and watched it on the grass through by field glasses. I never saw it again in the same place, and in fact I never saw the bird again in Colombo until this year, although I fancied that I heard its call note several times.

On January 18, 1913, at this place, the Government Analyst's Laboratory, near the Medical College, I heard a call note, very familiar in Nuwara Eliya, but strange for Colombo. On looking out of the window I saw a specimen of *Parus atriceps* searching for grubs on a papaw tree within three yards of the place where I was standing. I went out and watched the bird for a few minutes, after which it flew away

across the Medical College. I did not notice it here again until February 8. Since that date, I have seen it every day, and now for a few days I have noticed a pair of them, and they appear to be about to build a nest. Within ten yards of my office, a building is in course of construction, and, of course, bamboo poles are used for scaffolding. This scaffolding has been up for several months and is not at present in use, as the main structure is finished. Here *Parus atriceps* has an excellent opportunity of securing a ready-made nesting hole. I have seen the pair working at the end of one particular pole, carrying bits into it, and now I am anxiously awaiting the end of the story. The sparrows may evict them, or the scaffolding may be taken down ; but I have already told the workmen to let me know before they remove it. I hope to be able to exhibit the nest itself to the Society. So far the recent records rest upon my own authority, and that may be doubted.

But another observer, in the person of Mr. O. S. Wickwar, tells me that he has also seen a pair of these birds in Colombo within the last few months. So I am relieved of the necessity of bearing the whole responsibility myself.

Colombo, February 23, 1913. C. T. SYMONS.

THE CEYLON NATURAL HISTORY SOCIETY.

Fourth General Meeting.

THE Fourth General Meeting of the Society was held in the Colombo Museum, on Tuesday, December 17, 1912, at 5.30 P.M., when Rev. P. T. Cash presided, in the absence of the President. Mr. W. E. Wait read a Paper on "The Eggs and Nesting Habits of Ceylon Birds."*

Mr. Frederick Lewis read a Paper on "The Vegetation of the Hali-ela Tank." The subject of the Paper referred to the vegetation which sprang up after the bursting of the tank. The tank had previously been full of water for 40 years, and the Paper dealt with the types of plants which arose from the bottom of the tank after this period of inundation.

Dr. Oliver R. Pereira read a short Paper on "The Devil Bird," identifying the bird with the Mountain Hawk-Eagle. An interesting discussion arose, in which it was maintained that the Devil Bird was an owl, namely, the Brown Wood-Owl.

Dr. Pearson read two notes by Mr. W. Ormiston on "Bloodsucker Lizards eating small Birds," and "The Length of Life of Butterflies."

Several interesting exhibits were made of eggs, &c., in connection with the Papers read.

First Anniversary Meeting.

The First Anniversary Meeting (Fifth General Meeting) of the Society was held in the Colombo Museum, on Friday, February 28, at 5.30 P.M., with Mr. F. M. Mackwood, the President, in the Chair.

The Secretary read the progress report for the year 1912, which was adopted.

The following officers were elected for the ensuing year :—

President.—F. M. Mackwood.

Vice-Presidents.—V. A. Julius, Sir S. D. Bandaranaike; D. Andreas Nell.

Council.—R. N. Lyne, T. Petch, W. E. Wait, O. S. Wickwar.

Joint Secretaries and Treasurers.—Dr. Joseph Pearson, and W. A. Cave.

The President read a Paper on "The Distribution of Ceylon Butterflies."†

Mr. Gilpin Brown read a Paper on "Some First Principles of Microscopy," in which he dealt with certain fundamental aspects of the science of microscopy.

The President exhibited several interesting series of butterflies in connection with his Paper.

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* Printed in full on p. 21 of the present number of "Spolia Zeylanica."

† Printed in full on p. 36 of the present issue of "Spolia Zeylanica."

NOTES ON THE HOLOTHURIOIDEA OF THE INDIAN OCEAN.

By Joseph Pearson.

(With ten Plates.)

1.—THE GENUS HOLOTHURIA.

THE following notes on the littoral Holothurioidea of the Indian Ocean have been brought together during the preparation of a monograph on the subject. Zoogeographically the Indian Ocean cannot be separated from the tropical portion of the Pacific, since with few exceptions the species of littoral Holothurians of this region have a wide distribution extending from the east coast of Africa to the eastern portion of the Pacific. The majority of the Holothurians of Ceylon, for instance, occur throughout the tropical waters of the Indo-Pacific region, and are found on the east coast of Africa from Suez to the Cape of Good Hope, the coast of Asia from the northern end of the Red Sea to the islands of Japan, the East Indies, the north coast of Australia, the Pacific Islands, and in some cases the western coast of South America. On the grounds of not having sufficient material from the Pacific Ocean, and also in order to confine the work within reasonable limits, it has been decided to include only those Holothurians found in the waters which lie between latitudes 30° N. and 30° S. and longitudes 30° E. and 130° E.

The proposed monograph will be based upon collections examined and described by the present writer during the past few years. I refer to the collections made by Professor Herdman, F.R.S., in Ceylon, by Messrs. Simpson and Rudmose Brown in the Mergui Archipelago, by Mr. Simpson in Portuguese East Africa, and to the collection of Holothurians in the Colombo Museum. To these have been added the Holothurians sent by Professor Stanley Gardiner, F.R.S.,

from the Maldives and the Seychelles, a collection from the Red Sea sent by Mr. Cyril Crossland, Marine Biologist to the Sudan Government, and the collections made by the Federal Investigation ship "Endeavour" and the R. I. M. S. "Investigator" (other than those already described by MM. Koehler and Vaney). Through the kindness of the authorities concerned I have also been able to examine a very large and varied collection of Holothurians from the following Museums: the Indian Museum, Calcutta; the Australian Museum, Sydney; the South African Museum, Cape Town; the Durban Museum, Natal; the National Museum of Ireland, Dublin; the United States National Museum, Washington, D.C.; the Museum of Comparative Zoology, Harvard, Cambridge, Mass.; Zoologisches Institut, Kgl. Bayerische Universitat, Munich; Naturhistorisches Museum der Senckenbergischen Naturforschenden Gesellschaft, Frankfürt; Museum d'Histoire Naturelle, Geneva. An interesting collection has also been received from the Science College, Imperial University, Tokyo.

The following species are described in the present Paper :—

Holothuria hamata, n. sp.
Holothuria maculosa, n. sp.
Holothuria marmorata (Jäger).
Holothuria argus (Jäger).
Holothuria vitiensis, Semper.
Holothuria graffei, Semper.
Holothuria glaberrima, Selenka.
Holothuria lubrica, Selenka.
Holothuria cinerascens (Brandt).
Holothuria atra, Jäger.
Holothuria edulis, Lesson.
Holothuria monacaria (Lesson).
Holothuria vagabunda, Selenka.
Holothuria fusco-cinerea, Jäger.
Holothuria fusco-rubra, Théel.
Holothuria pardalis, Selenka.
Holothuria maculata (Brandt).
Holothuria rugosa, Ludwig.
Holothuria discrepans, Semper.
Holothuria impatiens (Forskaal).

Holothuria scabra, Jäger.
Holothuria spinifera, Théel.
Holothuria ocellata, Jäger.
Holothuria martensii, Semper.
Holothuria albiventer, Semper.

Genus **HOLOTHURIA.** Linn. 1758.

Bohadschia, Jäger 1833.
Trepang, Jäger 1833 (*partim*).
Sporadipus, Brandt 1835.
Cystipus, Haacke 1880.

Usually 20 peltate tentacles, exceptionally more or less. Ambulacral appendages pedicels alone, papillæ alone or with both (pedicels on the trivium and papillæ on the bivium). Ambulacral appendages generally scattered, very rarely disposed in rows. As a rule the trivium is not clearly separated from the bivium. The anus is devoid of calcareous teeth. There is a single bundle of genital tubes on the left side of the dorsal mesentery. Tentacular ampullæ present. The calcareous ring without posterior prolongations and without long retractor muscles, stone canals often numerous ; respiratory trees well developed, the left branch being intimately connected with a *rete mirabile*. Cuvierian organs often present.

HOLOTHURIA HAMATA, n. sp.

(Plate V.; Plate VI., fig. 2.)

Two examples from Suez Bay, 5–9 fathoms, dredged by Mr. Cyril Crossland.

One of the specimens was narcotized in alcoholic sea water before preservation, and has retained more or less the proportions of the living animal. It is 225 mm. long and 54 mm. broad. The other specimen was put immediately with strong spirit and is greatly contracted.

External Characters.—After several years' immersion in strong spirit the animals have lost all colour, and are of a uniform yellowish-brown, slightly darker on the bivium than on the trivium. I have the advantage of some manuscript

notes of the species made by Mr. E. Hindle some years ago, when the spirit had evidently not extracted all the colour. He wrote as follows :—" Each dorsal papilla is light brown, surrounding this is a band of light gray, and finally there is an outer band of brown spots, marking off the light gray band from the brown background of the dorsal surface. This arrangement of bands of colour varies slightly, but every papilla on the dorsal surface shades off into a light gray, which is marked by a few brown spots. The ventral surface is light gray faintly marked by a few small light brown spots." Ambulacral appendages papillæ only, which are to some extent non-retractile. Those on the bivium are somewhat irregularly scattered, but nevertheless show an arrangement into four rows. Along each side of the body are 20 large claw-like outgrowths, which give the body a characteristic appearance. These processes increase in length towards the middle of the body, where they are 20 mm. in length. On the ventral surface there are two rows of broad papillæ, about 30 in each row.

There are 20 dark brown tentacles surrounded by papillæ.

Internal Anatomy.—There is one Polian vesicle on the ventral side and one stone canal on the right side of the dorsal mesentery. As in *Holothuria spinifera* and the related species, the stone canal is very large. Of the two respiratory trees the right is the longer, but the left more bulky. There are no Cuvierian organs.

Spicules.—Both the specimens examined by me have been preserved for some years, and the spicules show signs of disintegration. The spicules are very closely packed and consist of tables and buttons. The tables have usually a very irregular and indefinite shape, probably due to their having been partly dissolved. The most perfect form has a disc 100 μ in diameter, having a large central hole and about ten peripheral holes, and the tower is surmounted by numerous blunt spines reminding one very much of the tables of *H. aculeata.* The most common type, however, has fewer holes and the edge of the disc is spinous. The tower has four upright and one transverse beam. The buttons are knobbed and are extremely irregular in shape. They have an average length of 40 μ.

Remarks.—This form has affinities with *H. spinifera* and the related species. Nevertheless the large claw-like outgrowths on the sides of the body make the identification of this form easy. But the two specimens under examination are very different in external appearance, owing to the fact that one specimen has undergone great contraction

HOLOTHURIA MACULOSA, n. sp.

(Plate VI., fig. 3.)

One specimen from Aldabra, near Île d'Esprit, collected by Mr. J. C. F. Fryer. 75 mm. long.

External Characters.—The specimen is evidently very much contracted owing to its preservation in spirit. Hence the body has a wrinkled appearance, and the ambulacral appendages are in a contracted condition. The ambulacral appendages consist of papillæ only, which are irregularly scattered over the whole body and show no arrangement with rows. The colour of the trivium is chocolate-brown with a yellowish-white circle 2 mm. in diameter around each papilla, thus producing a distinctly mottled appearance. The white patches seem to coalesce towards the posterior end of the body. The same contrast of colours is presented on the bivium, except that the brown is of a much darker shade, and is present along the middle of the back as a series of irregular patches which appear to be disposed in pairs. About five pairs of such markings are discernible, the smallest being about 8 mm. in diameter. In the same way the white does not confine itself to the papillæ, but in many places, especially towards the posterior end, there are large patches of white. Thus the bivium is not so regular in its markings as the trivium. There are five groups of papillæ around the anus. The tentacles are not present. The integument is very hard to the touch.

Internal Structure.—The calcareous ring is fairly large and the radials are massive. There is one long Polian vesicle and one small stone canal on the right side of the dorsal mesentery. The left respiratory tree is shorter, but more voluminous, than the right. Cuvierian organs are present.

Spicules.—These consist of tables and buttons. The tables are somewhat irregular, the disc has a diameter of 66 μ, and the edge of the disc is uneven, and sometimes spiny. The disc is perforated by a varying number of holes up to twenty-four. There is no large central hole. The tower is very short and irregular, and in many instances there appears to be only an irregular spiny mass on the disc in place of a tower. Sometimes a short tower can be seen surmounted by a number of spines. The buttons are knobbed and irregular and have a length of about 45 μ. The typical number of holes is six, but there is great variation in this respect, as also in the irregularities of the surface. The papillæ are supported by tables and buttons similar to those in the general integument, and in addition there are perforated "cups" 20 μ in length, and elongated rods 75 μ in length, with perforations at the centre and the extremities. The papillæ have rudimentary terminal plates.

Remarks.—This species is evidently allied to *Holothuria aculeata*, Semper, both as regards its external appearance to some extent and also its internal structure. The tables, however, differ from those described by Semper. Semper describes his species as being uniformly yellowish-white on the trivium and darker on the bivium, the latter being irregularly streaked with dark brown; and this description agrees very closely with the colour of the specimen under examination.

Holothuria marmorata (Jäger).

(Plate VII., fig. 4.)

Bohadschia marmorata, Jäger 1833 (14).*
Sporadipus (*Colpochirota*) *ualenensis*, Brandt 1835 (8).
Holothuria ualensis, Selenka 1867 (37); Semper 1868 (38).
Holothuria brandtii, Selenka 1867 (37).
Holothuria marmorata, Semper 1868 (38); Ludwig 1881 (25), 1882 (26), 1888 (30); Lampert 1885 (19); Théel 1886 (42); Slinter 1887 (39), 1901 (41); Bell 1887 (5); Pearson 1903 (33), 1910 (34).

* The numbers in brackets refer to the literature at the end of the Paper.

Holothuria utrimquestigmosa, Haacke 1880 (12).

Several specimens, Trincomalee, Ceylon. Average length 150 mm. × 70 mm.

External Characters.—A massive species with a fairly thick body wall. It is almost cylindrical in shape, slightly flattened dorso-ventrally, and the two extremities are bluntly rounded. The mouth is ventral and the anus is terminal or slightly dorsal. The colour of the body is auburn-brown, and here and there on the bivium and the sides of the body are irregularly marked deep violet-coloured patches. The ambulacral appendages are surrounded by small dark patches. The trivium is but little lighter in colour than the bivium. The ambulacral appendages are true pedicels, those on the trivium being slightly larger than the rest. The pedicels are irregularly scattered and very numerous. The anus is more or less pentagonal and is guarded by five groups of papillæ. There are twenty light-coloured tentacles.

Internal Structure.—The calcareous ring is massive, but in the specimens I have examined I do not find that, as Théel states, the calcareous ring is larger than that of *H. argus*. On the contrary, I find that the latter species has a slightly larger calcareous ring. I am in agreement with Théel in finding a single large Polian vesicle and one stone canal. Lampert has recorded four, five, to seven Polian vesicles, and Koehler (15) has made a point of this difference of evidence, but it is well known that the number of Polian vesicles is a variable character. The right respiratory tree is larger than the left, and the Cuvierian organs arise from the base of the left respiratory tree.

Spicules.—These consist of a superficial layer of numerous small branched " rosettes " 15 μ in diameter. The species is characterized by also having small globular spicules 18 μ in diameter in the deeper layers of the dermis. The pedicles are supported by ordinary rosettes and small H-shaped spicules 26 μ in length.

Distribution.—Shallow water of the tropical zone of the Indo-Pacific region. My own observations show that this species has a peculiarly localized distribution in Ceylon. In Trincomalee it is exceptionally abundant, and I have brought

up as many as fifty specimens after five minutes' dredging from a small boat. On the western side of the Island it is apparently very rare, as I have not found a single specimen during a two-months' trawling and dredging expedition in the shallow-water region to the north of Colombo. Professor Herdman obtained only a single specimen during his visit in 1902.

HOLOTHURIA ARGUS (Jäger).

(Plate VII., fig. 5.)

Bohadschia argus, Jäger 1833 (14); Bell 1889 (7).

Holothuria argus, Semper 1868 (38); Ludwig 1882 (26); Lampert 1885 (19), 1889 (20); Théel 1886 (42); Bell 1887 (6); Koehler 1895 (15); Sluiter 1901 (41).

One specimen from Ternate (Frankfürt Museum), 140 × 65 mm.

One specimen from Amboina (Geneva Museum), 295 × 70 mm.

External Characters.—Colour, yellowish-brown below and slightly darker above. The upper surface is characterized by the presence of numerous well-defined circles varying in diameter from 1 to 12 mm. In some cases several of these areas are joined up together, thus forming an irregular patch. The centre of each circle is occupied by a pedicel, the base of which is coloured dark brown; towards the circumference the integument gradually changes from yellow to dark brown; outside the circumference there is a light yellow area which gradually merges into the brown colour of the general integument. In addition to the pedicel in the centre of the circle, there are other ambulacral appendages irregularly arranged within the circle as well as on the general surface of the body.

The ambulacral appendages consist of pedicels. Those on the trivium have much better developed terminal discs. The pedicels are irregularly scattered and are extremely numerous, especially on the trivium. Some of the ambulacral appendages on the bivium are devoid of sucking discs and terminal plates.

The mouth is ventral and is surrounded by 20 tentacles. The anus is slightly dorsal. It is five-rayed, and surrounded by five groups of papillæ.

Internal Structure.—Internally this species resembles *H. marmorata*. The form of the calcareous ring is similar in both species. There is a single Polian vesicle and one stone canal. The right respiratory tree, which extends to the anterior end of the body, is larger than the left. The Cuvierian organs are not present in the specimen under examination, although they have been recorded from this species.

Spicules.—The deposits in the superficial integument are hardly to be distinguished from those of *H. marmorata*. The deposits in the deeper layers are, however, wanting in *H. argus*. The pedicels are supported by two kinds of spicules. First large rods generally perforated at both ends and 200 μ in length. There are also smaller irregular rods, often H-shaped, about 40 μ in length.

General Distribution.—Similar to that of *H. marmorata*. The latter species, however, is more abundant than *H. argus*.

HOLOTHURIA VITIENSIS, Semper.

(Plate VII., fig. 6.)

Holothuria vitiensis.—Semper 1868 (38); Lampert 1885 (19); Théel 1886 (42); Sluiter 1901 (41).

Holothuria tenuissima.—Semper 1868 (38); Ludwig 1882 (26); Lampert 1885 (19); Théel 1886 (42); Sluiter 1887 (39), 1901 (41); Pearson 1903 (33); Koehler & Vaney 1908 (17).

Holothuria similis.—Semper 1868 (38); Lampert 1885 (19); Théel 1886 (42).

Holothuria koellikeri.—Semper 1868 (38); Lampert 1885 (19); Théel 1886 (42); Ludwig 1887 (28).

Holothuria clemens.—Ludwig 1875 (23); Lampert 1885 (19); Théel 1886 (42).

There appears to be no doubt that the five forms described under the five different specific names given above should really be included under the same name. This has previously been suggested by Théel (42), Koehler & Vaney (17), and the present writer (33), although Koehler & Vaney united only the four species *vitiensis*, *tenuissima*, *koellikeri*, and *clemens* under the name *H. tenuissima*. Since, however, *H. vitiensis* was first described, that name takes precedence of *tenuissima*. I have added the fifth species, *similis*, which does not appear to differ from the other four, except according to Semper (38) in the possession of true papillæ all over the body. This form has not been re-discovered since Semper first described it. Seeing that so many mistakes have been made in differentiating true pedicels and papillæ, and since the appendages of *marmorata*, *argus*, and *vitensis* show every gradation between true pedicels and undoubted papillæ, one is justified in regarding *similis* as being identical with *H. vitensis*.

There are three specimens in the present collections. One specimen was obtained by me recently on the Ceylon Pearl Banks, and I am therefore able to supply a description of the living animal.

External Characters.—The ambulacral appendages are pedicels, scattered amongst which are what appear to be true papillæ. In the living animal the colour of the bivium is light brown with numerous minute dark brown spots, which, when closely examined, prove to be brown rings around the bases of the pedicels. In addition there are about a dozen larger spots of a darker hue very irregularly disposed along each side of the bivium. These spots are, however, quite different from the circles of *H. argus*. The trivium is white, and the pedicels show up faintly owing to their being of a slightly darker colour. Along each side of the body some of the pedicels of the bivium are surrounded by yellow rings. The contrast between the bivium and trivium is well marked, not only on account of the differences of colour, but also owing to the presence of a slight longitudinal ridge along each side of the body. After the specimen was placed in spirit

this ridge was not clearly seen, but the colour differences between the two surfaces were accentuated, the bivium turning a chocolate-brown and the trivium a light yellow. Other spirit specimens examined by me, however, are light yellow all over the body, the pedicels being marked out by a light brown ring around the base of each. The bivium is well arched, and the trivium is flattened. The body-wall is extremely thin, and owing to the absence of pigment on the trivium the internal organs can be faintly seen. The anterior end of the body is rounded, but the posterior portion tapers considerably. The mouth is ventral and is surrounded by twenty light yellow tentacles, and the buccal ridge bears numerous small papillæ. The anus is thrown on to the dorsal surface and appears round in the preserved specimen. In the living animal the pulsating anus is alternately pentagonal and rounded. There are five groups of papillæ guarding the anus. The pedicels are irregularly scattered, and the sucking discs are apparently not well developed, since the living animal does not appear to use them much.

Internal Structure.—The calcareous ring is similar to those of the two previous species. A single Polian vesicle and one stone canal are present. The right respiratory tree is larger than the left, and Cuvierian organs are present.

Spicules.—The spicules in the general integument agree with those of the two previous species. As in *H. argus*, there are no deposits in the deeper layers of the dermis. The pedicels are strengthened by irregular rods and H-shaped spicules similar in size and shape to those of *H. argus*, but the larger rods described in the latter species are not present in *H. vitiensis*.

General Distribution.—This species has a similar distribution to that of *H. marmorata*.

Remarks.—Undoubtedly the three species *H. marmorata*, *H. argus*, and *H. vitiensis* are closely allied, and it is only with some difficulty that I am able to discover any differences of sufficient value to justify the separation of the three forms. The colour differences are fairly clear if their constancy can be proved. I can vouch for the constancy of the colour of

H. marmorata found at Trincomalee, as I have examined hundreds of living specimens. The presence of a local race would, however, account for the constancy of this colour in the comparatively small area of Trincomalee Harbour. I cannot vouch for the constancy of the colour of the other two species, but I have not discovered any form having markings intermediate between the characteristic "circles" of *H. argus* and the irregular markings of *H. vitiensis*, nor has any other observer. An examination of the internal organs does not help much. It is true that I have found slight differences between the apparently similar calcareous rings of the three species, but I am quite prepared to find these differences break down upon an examination of a larger series. At first sight the spicules of the three forms are indistinguishable, but *H. marmorata* possesses calcareous grains in the deeper integument which are absent from the other two. This, then, clearly separates *H. marmorata* from *H. argus* and *H. vitiensis*. Sluiter (39) finds very little difference between the two latter species, except the thicker skin of *H. argus*. But apart from colour differences the pedicels show a difference in regard to the supporting spicules, *H. argus* having large supporting rods which are not present in *H. vitiensis*.

I give below a short key to distinguish the three species :—

A.—Small spherical spicules in the hypodermis.

.... *H. marmorata.*

B.—Spicules absent from the hypodermis—

(*a*) Dorsal surface conspicuously marked with circular patches. Spicules of pedicels, long bars with perforated ends 200 μ long, and smaller irregular often H-shaped spicules 40 μ long.

.... *H. argus.*

(*b*) Dorsal surface not possessing numerous circles. Spicules of pedicels consisting of rods 75 μ long and irregular H-shaped spicules 40 μ long.

.... *H. vitiensis*

HOLOTHURIA GRAFFEI, Semper.

(Plate VIII., fig. 7.)

Holothuria graffei, Semper 1868 (38); Ludwig 1882 (26); Lampert 1885 (19); Théel 1886 (42); Koehler 1896 (16); Sluiter 1901 (41).

Two specimens from Amboina (Geneva Museum), 180 mm. × 40 mm., 200 mm. × 45 mm. One specimen from Maldives (Gardiner), 140 mm. × 50 mm.

External Characters.—The ground colour is brown with numerous small dark spots scattered over the body. There are also some irregular dark brown patches on the bivium, chiefly around the papillæ. The ambulacral appendages consist of papillæ on the bivium and larger pedicels on the trivium. The pedicels are very large and are arranged in three well-defined rows, the middle row being broader than the two lateral ones and being about five or six pedicels thick in the middle of the body, but narrowing towards each end. The lateral rows are three pedicels thick at the middle of body and two towards each end. Near the anus the pedicels seem to give place to small papillæ which terminate near the edge of the anus. Anteriorly the pedicels stop at a distance of 20 mm. from the mouth. Near the anus the papillæ of the back appear to form two distinct rows, but very soon each row subdivides into three, so that along the greater part of the bivium there are about six irregular rows of papillæ. The mouth is surrounded by a rim of papillæ. There are 25 tentacles.

Internal Structure.—The calcareous ring is very large and is similar to that of *H. argus* and the related species. In the specimen dissected by me there were two Polian vesicles and a dozen stone canals, six on each side of the dorsal mesentery. The species appear to show considerable variation in regard to the number of stone canals and Polian vesicles. Cuvierian organs are present.

Spicules.—These consist of two kinds of bodies. First, there are numerous irregular fenestrated plates, and there are also irregular bodies which have been compared by previous

writers to imperfectly developed tables. They generally consist of two or three stout rods, sometimes trident-shaped, at other times like the tower of a typical Holothurian table. The speculations of previous writers as to the homology of these bodies with vestigial tables have little substantial support.

Remarks.—In the peculiar formation of the calcareous ring as well as in the general nature of the deposits this species shows relationship with *H. argus* and the allied species, from which, however, it differs in the abnormal number of its tentacles and in the arrangement of the ventral pedicels

General Distribution.—Indo-Pacific region.

HOLOTHURIA GLABERRIMA, Selenka.

(Plate VIII., fig. 8.)

Holothuria glaberrima, Selenka 1867 (37) ; Semper 1868 (38) ; Lampert 1885 (19), 1896 (21) ; Théel 1886 (42) ; Ludwig 1887 (28) ; Clark 1901 (9) ; Koehler & Vaney 1908 (17).

Holothuria erinaceus, Semper 1868 (38) ; Lampert 1885 (19) ; Théel 1886 (42).

Holothuria erinaceus, var. *pygmæa*, Semper 1868 (38) ; Lampert 1885 (19).

One specimen from Ternate (Frankfürt Museum).

Lampert (21) and Koehler & Vaney (17) have discussed the relationship of these forms and have thrown doubt upon Lampert's earlier opinion, with which Ludwig (31) agreed, that *Holothuria lubrica*, *Holothuria glaberrima*, *Holothuria erinaceus*, *Holothuria erinaceus* var. *pygmæa*, and *Holothuria parva* are identical. Although all these forms are undoubtedly related, I propose following Lampert and Koehler & Vaney in retaining *Holothuria lubrica* and *Holothuria parva* as distinct species, while including the remaining three under the name *glaberrima*.

External Characters.—The colour of the bivium is dark brown and the trivium is a lighter colour. There are twenty dark brown tentacles. On the bivium there are thinly-scattered papillæ of a small size and on the trivium there are

more numerous pedicels which are irregularly disposed. The anus is surrounded by a ring of papillæ.

Internal Structure.—Selenka speaks of the calcareous ring as being large, but in the specimen I have examined it is very small in comparison with most Holothurians. The allied form *Holothuria lubrica* has a large calcareous ring. There is a single Polian vesicle 4 mm. long and a large stone canal arising from the right side of the dorsal mesentery. This stone canal is over three times as long as the Polian vesicle. Cuvierian organs are present.

Spicules.—These consist of flattened plates, which in their complete state have a solid longitudinal axis bordered by numerous small holes. The holes along the course of the longitudinal axis frequently break down and produce perhaps the commonest type of spicules, which is a long rod having swollen ends which are perforated. All stages between these two extremes are seen. The spicules vary from 56 μ to 84 μ in length, with a mean length of 66 μ.

General Distribution.—This form has a world-wide distribution in tropical and sub-tropical waters, and is found in the Pacific, Indian, and Atlantic Oceans.

HOLOTHURIA LUBRICA, Selenka.

(Plate VIII., fig. 9.)

Holothuria lubrica, Selenka 1867 (37); Semper 1868 (38); Ludwig 1882 (26), 1887 (28), 1898 (31), 1899 (32); Lampert 1885 (19), 1896 (21); Théel 1886 (42); Sluiter 1901 (41); Koehler & Vaney 1908 (17).

I have one specimen, collected by Professor C. Ishikawa on Japanese waters. This is labelled *Holothuria lubrica* var. *moebii*, but it differs in no way from *Holothuria lubrica* and does not possess the essential characters of *Holothuria moebii.*

External Characters.—The spirit specimen measures 50 mm. in length and 20 mm. in breadth, but it is much contracted and wrinkled. It is with difficulty that the ambulacral appendages, consisting of pedicels below and papillæ above,

can be made out. The specimen is dark brown on the bivium and a lighter shade on the trivium.

Internal Structure.—Koehler & Vaney state that the calcareous ring is similar to that of *Holothuria glaberrima.* So far as the shape is concerned this is true, but the calcareous ring of *Holothuria lubrica* is much larger and more massive than that of the other species. There is a single Polian vesicle 12 mm. long and numerous stone canals, about eight on each side of the dorsal mesentery, having a mean length of about 5 mm. The specimen under examination has ejected its viscera, so that I cannot say whether Cuvierian organs are present or not. Ludwig is the only writer who records the presence of Cuvierian organs.

Spicules.—These consist of spinous rods varying in length from 112 μ to 148 μ, and having a mean length of 127 μ. The rods are often curved, and have fine spines along their length. The extremities are spinous and often perforated.

General Distribution.—Indo-Pacific region.

My examination of *Holothuria glaberrima* and the above species shows differences of three kinds :—(1) The large size of the calcareous ring of *lubrica* and the small size of that of *glaberrima ;* (2) the presence of numerous small stone canals on both sides of the dorsal mesentery in *H. lubrica* and the presence of only one extremely large stone canal in *H. glaberrima ;* (3) the nature of the spicules as described above.

Whether the first of these differences is constant, I cannot say. Selenka, however, states that the calcareous ring of *H. glaberrima* is large, whereas I find it very small. Koehler & Vaney also speak of the calcareous rings of the two species as being identical. In my specimens they are similar in shape but not in size.

The difference in the number and size of the stone canals may not appear to be a very important one, since it is well known that these organs are very variable ; but it is doubtful whether the variability is so great as shown by the specimens I have examined. Most of the records of the two species lend support to my emphasis of this difference. Nevertheless Ludwig (31) describes a specimen which had spicules like

H. glaberrima in which there were four stone canals, and another specimen which had spicules like *H. lubrica* but had only one long stone canal. These results are quite contrary to my observations.

Similarly there appears to be much variation in the size of the spicules of *H. glaberrima* and *H. lubrica*, and also according to Ludwig in regard to the shape of the deposits. In the specimens examined by me the spicules do not show intermediate stages linking up the two species. With regard to the size of the spicules my specimens of *H. glaberrima* show a length variation from 56 μ to 84 μ, with a mean length of 66 μ. The spicules of *H. lubrica* vary from 112 μ to 148 μ, with a mean length of 127 μ; that is to say, the spicules of the latter species are nearly twice as long as those of the former.

In Selenka's original description (37) he gave the length of the spicules of *H. glaberrima* as 50 μ and of *H. lubrica* as 60 μ. Lampert (21) gave the size of the spicules of the former species as 105 μ and of the latter as 70 μ, exactly the reverse of what I find. Hence the size of the spicules in the two species varies to a very large degree.

It is seen, then, that all three points of difference between the two species are dependent upon characters which have been shown to be inconstant, and it is possible that Ludwig's opinion that the two forms really belong to the same species may be eventually borne out when a sufficiently long series of specimens has been brought together for examination. In the meantime I follow Lampert and Koehler & Vaney in separating the two species.

HOLOTHURIA CINERASCENS (Brandt).

(Plate IX., fig. 10.)

Stichopus (Gymnochirota) cinerascens, Brandt 1835 (8).
Holothuria pulchella, Selenka 1867 (37); Semper 1868 (38); Haacke 1860 (12); Ludwig 1881 (25), 1883 (27): Théel 1886 (42); Sluiter 1887 (39); Bell 1887 (6).

Holothuria cinerascens, Lampert 1885 (19); Ludwig 1887 (28), 1897 (32); Sluiter 1901 (41); Bedford 1902 (3).
Holothuria willeyi, Bedford 1902 (3).

Several specimens from the Maldives (Gardiner), Seychelles (Dublin Museum), and Ceylon (various localities).*

External Appearance.—Reddish-brown colour, lighter below and with some irregular dark patches above. The trivium is clearly separated from the bivium by reason of the disposition of the ambulacral appendages. Those on the trivium are pedicels which are closely arranged. There is sometimes a very narrow bare area in the mid-ventral line which separates the pedicles into two groups. The papillæ on the bivium are few in number and smaller in size than the pedicels, and are irregularly scattered. There are twenty large yellow tentacles.

Internal Structure.—The calcareous ring is large, the radial pieces being very well formed. In the specimens I have dissected there are two large Polian vesicles, one on the central radius of the trivium and one on the left radius of the bivium. There is a single stone canal on the right side of the dorsal mesentery. In this species both the Polian vesicles and stone canals vary in number to a considerable degree. The right respiratory tree extends to the anterior end of the body, but is very delicate. The left respiratory tree is much shorter, but more massive. Cuvierian organs are not present in the specimen examined by me, but they have been recorded in this species.

Spicules.—The deposits consist of small tables and spiny rods. The tables are intermediate between those of *H. atra* and *H. edulis*, but smaller. Sometimes the disc consists of a simple ring as in *H. edulis*, but in the more perfect condition it is more like that of *H. atra*. The diameter of the disc is 36 μ. The height of the table is about 40 μ, and it has a spiny top similar to that seen in *H. atra*. The spiny rods are similar to those of *H. lubrica*. They are slightly curved and are covered with very minute spines, which are larger at the two extremities. The rods are about 100 μ in length and 16 μ in width.

General Distribution.—Indo-Pacific region.

Remarks.—It would appear that this form is related to *Holothuria atra* and *Holothuria edulis* on the one hand and to *Holothuria lubrica* on the other. I cannot see any important differences between the above species and *Holothuria willeyi*, Bedford. In some specimens from Ceylon which I have examined the spicules vary from the type as Bedford's specimens did, but this variation appears to accompany the breaking up of the spicules. I consider Bedford's species properly belongs to *H. cinerascens*.

Holothuria atra, Jäger.

(Plate IX., fig. 11.)

Holothuria atra.—Jäger 1833 (14); Selenka 1867 (37); Semper 1868 (38); Ludwig 1881 (25), 1882 (26), 1887 (28) (29), 1899 (32); Lampert 1885 (19), 1896 (21); Théel 1886 (42); Bell 1887 (6), 1889 (7); Thurston 1890 (43); Koehler 1895 (15); Whitelegge 1897 (45), 1903 (46); Bedford 1898 (2), 1899 (3); Clark 1901 (9), 1902 (10); Voeltzkow 1902 (44), Pearson 1903 (33), 1910 (34); Fisher 1907 (11); Koehler & Vaney 1908 (17).

Holothuria amboinensis.—Jäger 1833 (14); Semper 1868 (38); Lampert 1885 (19).

Holothuria (*Microthele*) *affinis.*—Brandt 1835 (8).

Holothuria floridana, Pourtalès 1851; Selenka 1867 (37); Ludwig 1881 (25).

Holothuria atra var. *amboinensis.*—Théel 1886 (42); Bedford 1898 (2), 1899 (3).

Numerous specimens from every collection which I have examined. This is a very common species in the shallow waters of the Indo-Pacific.

In living specimens I have examined from the Ceylon Pearl Banks the colour was black or very dark brown or reddish-brown. The pedicels have white sucking discs, and the papillæ have white tips. The columns of the pedicels and papillæ are always black. Twenty dark brown or dark green tentacles.

There are small scattered papillæ on the bivium and more numerous and larger pedicels on the trivium, so that the two surfaces are clearly distinguished. In the living condition the back often appears almost smooth owing to the insignificant size of the papillæ. This species may attain a length of 350 mm., but it generally contracts to half its length when preserved.

Internal Structure.—The calcareous ring is of the usual aspidochirote type and is not very large. This form is interesting, because the number of Polian vesicles and stone canals varies in different individuals, the number generally being much higher than in most Holothurians. I have counted from one to five Polian vesicles and up to twenty-seven stone canals. The circum-œsophageal ring is some distance behind the calcareous ring. The right respiratory tree extends up to the calcareous ring, but is very delicate; the left respiratory tree is shorter, but much more bulky. I have examined a great number of living specimens but have never seen any Cuvierian organs. The collected evidence goes to show that these organs are absent in the above species. In one specimen a small crab was found in the œsophagus at the level of the calcareous ring. Whether it had been taken in with the sand which passes through the alimentary canal, or whether it was living commensally, I cannot say.

Spicules.—The deposits of this well-known form consist of tables and somewhat irregular perforated plates. The tables are almost square in plan view and are 50 μ in diameter and 60 μ high, and generally consist of four large central holes with a small hole at each of the four corners. Occasionally, however, there may be an almost complete ring of small holes, and the edge of the disc may be spinous. The tower consists of four uprights joined by a transverse beam, and having four sets of well-developed spines on the summit. The perforated plates vary in shape and are not more than 25 μ in diameter.

Remarks.—The two forms of *H. atra* which Théel and Bedford regarded as distinct differ in respect of the spicules and colour. The one form, *H. atra* var. *amboinensis*, is black and has spines on the edges of the tables. The other, *H. atra*, is black but may have the papillæ and tube feet with whitish

ends, and the edges of tables are not usually spinous. Théel, however, has pointed out that *H. atra* sometimes has a spiny disc, and Bedford has shown that *amboinensis* may have no spines on the disc. The colour differences are apparently not constant, so that the distinctions between the two forms do not appear to be well defined.

H. pulla, Selenka, resembles *H. atra* in general appearance and in deposits, calcareous ring, and in the large number of the stone canals. But it has Cuvierian organs according to Théel, and it is this character alone which separates it from *H. atra.*

Distribution.—A shallow-water species, generally found within the 10-fathoms line and often between tide-marks. Principally Indo-Pacific, where it appears to be universally distributed between latitude 25° N. and 25° S. Also found in few places in West Indian area of Atlantic.

Holothuria edulis, Lesson.

(Plate IX., fig. 12.)

Holothuria edulis, Lesson 1830 (22); Semper 1868. (38); Ludwig 1882 (26), 1887 (29), 1888 (30), 1899 (32); Lampert 1885 (19); Théel 1886 (42); Sluiter 1901 (41); Koehler 1896 (15); Bedford 1899 (2); Koningsberger 1904 (18).

Trepang edulis, Jäger 1833 (14).

Holothuria fusco-cinerea, Selenka 1867 (37), (non Jäger).

Holothuria signata, Ludwig 1875 (23); Lampert 1885 (19), 1895 (21); Théel 1886 (42).

? *Holothuria albida*, Bell 1887 (5).

Numerous specimens from the various collections under examination. This is a very common Indo-Pacific littoral form, which is used as *beche-de-mer*.

External Characters.—I have been able to examine large numbers of living specimens from Ceylon, and they always have a very characteristic appearance. The ground colour of the skin is a bright rose-pink, which may be disguised by

varying degrees of black pigment. The black is very well marked on the bivium, where it varies from a grayish colour to an intense black, which at each side is gradually replaced by pink. The trivium is nearly always devoid of black. When preserved in spirit this species loses its pink colour and generally appears black above and gray below. There are pedicels on the trivium and papillæ on the bivium. The tube feet are readily distinguished, as each one is generally surrounded by a narrow black ring and has a white sucking disc. An arrangement into three rows is sometimes discernible. The papillæ are small and not very numerous. They are generally of the same colour as the general integument, so that they are not easily seen. There are twenty pinkish-white tentacles surrounded by a rim of small black papillæ. The anus is round and the diaphragm is black.

The living animal is long and narrow and may measure up to 400 mm. in length and 50 mm. in width. Spirit specimens are much shorter than this.

Internal Structure.—Internally this species differs but little from *Holothuria atra.* In both species the calcareous ring is similar, the Polian vesicles and stone canals are numerous and variable, and there are no Cuvierian organs present. The number of Polian vesicles varies from one to three, and the stone canals vary in number from 20 to 40, being disposed on each side of the dorsal mesentery. The circum-œsophageal ring is about 20 mm. behind the calcareous ring. Both right and left branches of the respiratory tree are large and of equal size.

Spicules.—These are similar to those of *Holothuria atra,* except that the disc of the tables is represented only by a ring.

Distribution.—Littoral waters of the Indo-Pacific region.

Remarks.—This species is undoubtedly related to *Holothuria atra,* but differs from the latter in the colour of the body and in the nature of the calcareous tables. I have had the opportunity of examining large numbers of this species on the Ceylon Pearl Banks, and have always found the pink colour to predominate over the black. At Trincomalee and Jaffna,

on the other hand, the pink colour was confined to a narrow strip on the middle of the trivium. The sides were gray and the middle of the bivium was black. Nevertheless there was no difficulty in distinguishing these dark-coloured specimens from *Holothuria atra*. On no occasion have I found any variation in the nature of the tables in the skin. I consider this species a good one, showing small but constant variations from *H. atra*.

HOLOTHURIA MONACARIA (Lesson).

(Plate X., fig. 13.)

Psolus monacaria, Lesson 1830 (22); Jäger 1833 (14).
Holothuria flammea, Quoy & Gaimard 1833 (36).
Holothuria fusco-punctata, Quoy & Gaimard 1833 (36).
Holothuria fasciola, Quoy & Gaimard 1833 (36).
Stichopus flammeus, Brandt 1835 (8).
Stichopus gyrifer, Selenka 1867 (37).
Labidodemas leucospilus, Haacke 1880 (12).
Holothuria monacaria, Lampert 1885 (19), 1889 (20), 1896 (21); Théel 1886 (42); Sluiter 1887 (39), 1901 (41); Ludwig 1887 (29), 1888 (30), 1899 (32); Koehler 1895 (15), (16); Bedford 1898 (2), 1899 (3); Pearson 1903 (33), 1910 (34); Fisher 1907 (11).

This species is well represented in the various collections under examination.

External Characters.—A well-marked form. There are papillæ on the bivium and pedicels on the trivium. The ground colour on the back is auburn, that on the trivium brown. The pedicels and papillæ are canary-yellow, and each one is surrounded by a light circular patch. Sometimes these light areas join up longitudinally so as to give a longitudinally striped appearance. The pedicels are slightly more crowded than the papillæ. Generally the pedicels are arranged in three double rows, but in some living specimens I have examined there was no such arrangement. The papillæ are arranged in about six more or less regular rows running along

the bivium. There are twenty light yellow tentacles. Around the base of the flattened head of each tentacle there is a row of small black spots. The mouth is surrounded by a ring of small papillæ, and there are five small groups of papillæ around the anus.

Internal Anatomy.—The internal organs call for no special mention. The calcareous ring is very small and the inter-radial pieces in particular are extremely delicate. There are one or two Polian vesicles and a single stone canal.

Spicules.—These consist of tables and buttons in the general integument. The tables have a base 65 μ in diameter perforated by a large central hole and about ten or a dozen small peripheral holes. The tower is 60 μ high and has one cross beam, and is surrounded by about eight irregular teeth. The buttons are 65 μ long and are smooth, and have three pairs of holes. There are irregular rods in the papillæ and fenestrated plates in the pedicels.

General Distribution.—A common form in the shallow waters of the tropical Indo-Pacific region.

So far as one can gather from Bell's scanty description and from the figures of the spicules given by him, *Holothuria macleari* would appear to be the same as *H. monacaria*, as Théel has suggested. Bell does not give the colour of his species, but his description of the arrangement of the pedicels and papillæ and the presence of white rings around them, together with the appearance of the deposits, would serve equally well as a description of *H. monacaria*. Further, he shows that the buttons are smooth, so that if reproduced correctly they cannot resemble those of *H. scabra* (*tigris*), as he suggests, since the latter species has knobbed buttons. This mistake is probably due to the incorrectness of Selenka's figure of the buttons of *H. scabra*.

I have before me a single specimen from the collection of the late Professor Mitsukuri of Tokyo, labelled *H. macleari*, but I have not the slightest hesitation in assigning this specimen to *H. monacaria*, both on account of the external appearance and general characters; and also because of the nature of the deposits.

HOLOTHURIA VAGABUNDA, Selenka.

(Plate X., fig. 14.)

Stichopus (*Gymnochirota*) *leucospilota*, Brandt 1835 (8).
Holothuria vagabunda, Selenka 1867 (37) ; Semper 1868 (38) ; Ludwig 1875 (23), 1882 (26), 1883 (27), 1887 (29), 1888 (30), 1881 (25), 1899 (32) ; Lampert 1885 (19) ; Théel 1886 (42) ; Bell 1889 (7) ; Koehler 1895 (15), (16) ; Whitelegge 1896 (45) ; Bedford 1898 (2), 1902 (3) ; Sluiter 1901 (41) ; Pearson 1903 (33), 1910 (34) ; Koningsberger 1904 (18) ; Fisher 1907 (11) ; Koehler & Vaney 1908 (17).

Numerous specimens from most of the collections under examination.

A very common littoral species of the Indo-Pacific littoral waters.

External Characters.—The body is dark brown, the ambulacral appendages black tipped with white, and the tentacles are greenish-brown or dark brown. Ambulacral appendages are papillæ on the bivium and pedicels on the trivium. Some of the earlier writers state that true pedicels only are present on the bivium. The dorsal appendages, although elongated, have no sucking discs, and may therefore be regarded as papillæ. The long fine papillæ are numerous and can be extended to a length of 7 mm. They are tipped with white and show no arrangement with rows. Owing to their length they give the living specimen a somewhat ragged appearance. The pedicels of the trivium are still more numerous, but show no arrangement into rows. They are terminated by white sucking discs. Twenty tentacles are present, surrounded by a rim of black papillæ. The anus is round. Living specimens may measure up to 380 mm. in length and 65 mm. in width.

Internal Structure.—The calcareous ring is normal. Usually there is one Polian vesicle and one stone canal present. The respiratory trees are well developed. Cuvierian organs are present, and in the living specimen have a purplish colour.

Deposits consist of tables and buttons. The tables have a disc 50 μ in diameter. In young specimens the disc is

perforated by ten or a dozen holes, but in older specimens there are generally only four peripheral holes. The tower is 35 μ high and consists of four uprights connected by one cross beam, and is terminated by a ring bearing eight or ten spines. The buttons are 50 μ in length and have three pairs of holes. There are also perforated plates in pedicels and irregular spinous or perforated supporting rods in the papillæ.

General Distribution.—A common Indo-Pacific form.

Remarks.—Although this species should, strictly speaking, be named *leucospilota*, the name *vagabunda* is in such universal use, that the demands of priority should be waived. This has evidently been the view of every writer since Ludwig showed in 1875 that *Stichopus leucospilota*, Brandt, is identical with *Holothuria vagabunda*, Selenka. At any rate no one has used the rightful name, and I see no reason to adopt a different course.

In 1886 Théel suggested that *H. vagabunda* and *H. lagæna* were identical, and in 1895 Koehler (16), after an examination of specimens from different localities, proposed to unite the two, but in 1908 Koehler & Vaney did not give *H. lagæna* as a synonym of the species, so that one is led to conclude that Koehler did not maintain his earlier view. I have had no opportunity of examining a specimen agreeing with *H. lagæna*, so that I am unable to throw any light upon the question.

HOLOTHURIA FUSCO-CINEREA, Jäger.

(Plate X., fig. 15.)

Holothuria fusco-cinerea, Jäger 1833 (14); Lampert 1885 (19); Théel 1886 (42); Ludwig 1882 (26), 1887 (29); Sluiter 1887 (39).
Holothuria pervicax, Selenka 1867 (37); Ludwig 1897 (32); Sluiter 1901 (41); Fisher 1907 (11).
Holothuria depressa, Ludwig 1875 (23); Lampert 1895 (21).
Holothuria mammiculata, Haacke 1880 (12).
Holothuria fusco-cinerea var. *pervicax*, Bedford 1898 (2).
Holothuria dofleinii, Augustin 1908 (1); Pearson 1910 (34).

There are about twenty specimens in the collections under examination.

External Characters.—There is a distinct separation of the bivium from the trivium, the latter bearing pedicels only, and the former papillæ. The general ground colour of the spirit specimens is grayish-yellow. The pedicels, which do not show any arrangement into rows, are brown-coloured with yellow sucking discs. Each pedicel is surrounded by a white ring. On the bivium the papillæ are situated on the summits of warts of various sizes, the largest being arranged in two rather irregular rows near the middle of the back. There are about six in each row, and each of these is surrounded by a broad bluish-black area, which joins with the dark area around the corresponding papillæ of the other row to form a transverse band. There are about six of these bands. In some cases the dark area in question is separated from the papilla by a light ring, as described by Augustin (1). The smaller papillæ are arranged irregularly, although there is a slight suggestion of an arrangement into rows, especially near the junction of the bivium and trivium. Most of these small papillæ are dark-coloured and are surrounded by a light ring. The tentacles were not seen in any of the specimens.

Internal Structure.—The calcareous ring is typical of the genus. There is a single stone canal on the right side of the dorsal mesentery, and there is a single Polian vesicle. The left respiratory tree is larger than the right, and Cuvierian organs arise from the base of the left respiratory tree. In the specimens examined the gonads were well developed and extended to the posterior end of the body.

Spicules.—The calcareous deposits consist of tables and buttons. The tables have a disc 40 μ in diameter, generally consisting of four larger central holes and alternating with these four smaller peripheral holes. The spire is generally imperfectly formed and has no definite shape. It may consist of three or four uprights which do not join at their summit, or there may be two irregular uprights diverging towards the summit, where they are connected by an irregular cross beam. These tables are hardly to be distinguished from those of *H. curiosa.* The buttons consist of a central axis, from which are given off from three to six irregular outgrowths at each side, and are about 20 μ in length. They remind one strongly of

the buttons of a typical Holothurian, in which the outer walls bounding the holes of the buttons have been broken down. Nevertheless the perfect button is very rarely found in this species. These buttons differ from those of *H. curiosa.*

General Distribution. — The Indo-Pacific region. Not very common.

Remarks.—The specimens which I have under examination differ in no respect from those described by me in 1910 (34), and which I identified as *H. dofleinii*, Augustin. On further examination I believe that this species is identical with *H. fusco-cinerea*, Jäger, and *H. pervicax*, Selenka. I consider that Augustin's grounds for not including his specimens under *H. fusco-cinerea* are insufficient. The two reasons for his not doing so are the presence of white rings around the papillæ in his specimens and the character of the buttons. With regard to the first of these, I have before me sufficient material to state that the colour of the rings around the papillæ varies to a considerable degree. As for the spicules I cannot see any difference of sufficient importance to justify Augustin's new species.

There is no doubt that Semper's *Holothuria fusco-cinerea* is identical with *H. curiosa*, Ludwig, and not with Jäger's species, although *H. fusco-cinerea*, Jäger, and *H. curiosa*, Ludwig, are undoubtedly closely related. But I do not agree with Bedford and Théel that *H. curiosa* should be included in *H. fusco-cinerea*, Jäger, since the colour markings and the buttons are different in the two forms. Ludwig (23) describes his *H. depressa* as having a grayish-brown colour and three or four transverse brownish marks; on the trivium the pedicels were numerous, and on the bivium the papillæ were sparsely scattered and situated upon wart-like elevations, the tips of which had a dark colour. The pedicels of the trivium were each surrounded by a light ring.

Selenka's (37) short diagnosis and Fisher's (11) exhaustive description of *Holothuria pervicax* agree with the account of *H. fusco-cinerea* which I have given above.

I cannot agree with Bedford that *H. argus* is allied to this form. In external appearance, in the nature of the spicules and calcareous ring, that species differs greatly from *H. fusco-cinerea*

HOLOTHURIA FUSCO-RUBRA, Théel.

(Plate XI., fig. 16.)

Holothuria fusco-rubra, Théel 1886 (42); Sluiter 1901 (41); Fisher 1907 (11).

A few specimens are found in the collections under examination.

External Characters.—Body is robust, and is covered with numerous well-formed pedicels on the trivium and less numerous papillæ on the bivium. There are five groups of papillæ around the anus. There are twenty tentacles. The body is purplish-brown in alcohol. This colour is seen in the sections of the integument which it is customary to prepare for the microscopical examination of the spicules.

Internal Structure.—In the specimen examined by me the calcareous ring is slightly different from that figured by Théel. There are two Polian vesicles and a single stone canal. The left respiratory tree is more bulky than the right, but does not extend so far forward. Théel and Fisher stated that the species possesses Cuvierian organs, but they are not present in the specimen under examination.

Spicules.—These consist of tables and buttons. The disc tables vary in size according to the state of their development. The largest tables are 55 μ in diameter, and have four central holes and a ring of smaller peripheral holes. The edge of the disc is spiny. The tables are reduced or absent. Frequently the disc is reduced and possesses no peripheral holes, and then has the appearance of the reduced disc of *H. pardalis*. The buttons are irregular. In their most regular form they have three pairs of holes and are about 65 μ long. Frequently some of the holes are missing, and these asymmetrical forms are the commonest. The pedicels are supported by long irregular buttons having several pairs of holes. The papillæ are supported by irregular branched rods.

Distribution.—Indo-Pacific. Not very common.

HOLOTHURIA PARDALIS, Selenka.

(Plate XI., fig. 17.)

Holothuria pardalis, Selenka 1867 (37) ; Semper 1868 (38) ; Ludwig 1880 (24), 1882 (26), 1883 (27), 1887 (28), (29), 1888 (31), 1899 (32) ; Bell 1884 (4) ; Lampert 1885 (19), 1889 (20), 1895 (21) ; Théel 1886 (42) ; Sluiter 1887 (39), 1901 (41) ; Herouard 1893 (13) ; Koehler 1895 (15), (16) ; Whitelegge 1817 (45) ; Bedford 1898 (2) ; Voeltzkow 1902 (44) ; Fisher 1905 (11) ; Koehler & Vaney 1908 (17).

Holothuria subdivita, Selenka 1867 (37) ; Semper 1868 (38) ; Lampert 1885 (19) ; Théel 1886 (42).

Holothuria insignis, Ludwig 1875 (23), 1883 (27) ; Lampert 1885 (19) ; Théel 1886 (42).

Holothuria lineata, Ludwig 1875 (23), 1880 (24), 1882 (26), 1883 (27) ; Bell 1884 (4) ; Lampert 1885 (19) ; Théel 1886 (42) ; Pearson 1910 (34).

Holothuria peregrina, Ludwig 1875 (23) ; Bell 1884 (4) ; Lampert 1885 (19) ; Théel 1886 (42).

Holothuria pardalis var. *insignis*, Sluiter 1890 (40) ; Bedford 1899 (3).

This is a very widely spread species, and well represented in the various collections I have had the opportunity of examining.

Owing to this species being subject to considerable variation, both in colour and in the form of the spicules, much confusion has arisen with regard to its identity, and consequently the synonymy is somewhat intricate.

External Appearance.—The colour is yellowish-brown above and lighter below. Along the bivium there are frequently from five to ten pairs of dark brown patches, which give the species a characteristic appearance. Occasionally, however, these patches are wanting. The ambulacral appendages appear to be all true pedicels, which are not arranged in rows. Those on the trivium are more abundant than those on the bivium and are slightly larger. There is a circle of small papillæ around the anus. There are twenty small tentacles. Fisher (11) says the number is variable.

Internal Structure.—The calcareous ring is very small and presents no points of interest. There are one or two long, fine, Polian vesicles. The stone canal is evidently very small, as I have been unable to determine its presence in several specimens. Other observers have noted the presence of one or two stone canals. The left respiratory tree is more bulky than the right, but not so long. There are no Cuvierian organs.

Spicules.—These consist of tables and buttons. The tables when fully developed have a disc 60 μ in diameter, consisting of a central hole apparently divided into four when seen from below, owing to the presence of the four beams of the tower. There are also about eight smaller peripheral holes. The edge of the disc is slightly irregular, as though suggesting the presence of still another circle of holes in perfect condition, although in some specimens the edge is quite smooth, as in *H. bowensis*. When seen in side view the edge of the disc turns up slightly. The tower is generally short, and consists of four uprights connected by a single cross beam. Occasionally a fairly tall tower is seen. The top of the tower is square and bears a few blunt spines. The type of table described above is, however, rarely seen in the adult. The common form has a disc with an irregular edge, in which the outer circle of holes has broken down, leaving either only four holes, one at each corner, or no peripheral holes, or even no holes at all. In such tables the tower is frequently reduced and may be absent altogether. The buttons are very irregular. Typically they are smooth buttons with three or four pairs of holes. Often, however, some of the holes are missing, and thus the characteristically asymmetrical appearance is produced. Often the buttons are slightly twisted when seen in side view.

The buttons are usually arranged in groups or circles, but in many of the specimens I have examined this arrangement is not very clear, due probably to the contraction of the integument. The pedicels are supported by robust curved rods, which are perforated at each end. There appear to be two distinct types of spicules, as Fisher (11) states. In some specimens the tables are large and well developed, and the buttons frequently have four holes. In the majority of specimens, however, the tables are reduced and the buttons are very irregular.

Distribution.—A very common form in the Indo-Pacific tropical and sub-tropical littoral waters.

Remarks.—This species is related to *H. fusco-rubra* and *H. curiosa.*

HOLOTHURIA MACULATA (Brandt).

(Plate XI., fig. 18.)

Sporadipus (*Acolpos*) *maculata*, Brandt 1835 (8).

Holothuria arenicola, Semper 1868 (38); Théel 1886 (42); Sluiter 1887 (39); Fisher 1907 (11).

Holothuria maculata, Ludwig 1881 (25), 1883 (27), 1887 (28), 1888 (30), 1897 (32); Lampert 1885 (19), 1895 (21); Bedford 1898 (2), 1899 (3); Sluiter 1901 (41); Clark 1902 (10); Koningsberger 1904 (18); Koehler & Vaney 1908 (17).

There are numerous specimens of this species in the collections under examination.

External Characters.—The ground colour of the body is yellowish-white or pinkish-white; on the trivium there are a few scattered small brown spots. On the bivium there are two rows of dark brown patches, varying from six to fifteen in each row in different specimens. Occasionally these markings are absent altogether. There are twenty small tentacles. The ambulacral appendages are similar all over the body, and are apparently true pedicels, as they have well-developed sucking discs. These appendages are irregularly scattered, and appear to be equally abundant on the trivium and bivium. The anus is pentagonal and is surrounded by five groups of papillæ.

Internal Structure.—The calcareous ring is well developed. There is generally a single small Polian vesicle and small stone canal present. In a specimen examined by Théel there were two Polian vesicles and a bundle of three stone canals on the right side of the dorsal mesentery. No Cuvierian organs are present in any of the specimens examined by me, but their presence has been recorded by previous writers. The

respiratory trees are well developed, that on the right side being longer than the left, but not so large.

Spicules.—In the general integument there are tables and smooth buttons. The tables have a disc 60 μ in diameter, which has four large central holes and a varying number of peripheral holes. The tower is of the ordinary type and is surrounded by numerous spines, and is 42 μ high. The buttons have three pairs of holes and are 50 μ long. They are extremely thick. The supporting rods of the pedicels are curved rods 100 μ in length, and have perforated enlargements at each end and in the middle.

Distribution.—Tropical waters of the Indo-Pacific region.

Remarks.—Fisher (11) has pointed out that the name *maculata*, which is generally given to this species, must give place to *arenicola*, since the former name was given to a species of the same genus by Chamisso & Eysenhardt in 1821. But this species, which was first named *Holothuria maculata* in 1821, and later on *Fistularia maculata* in 1834, is now known as *Synapta maculata*. The species under discussion, on the other hand, was first described in 1835 under the name *Sporadipus maculatus*, a designation which is not invalidated by any of the synonyms of *Synapta maculata*. *Holothuria maculata* was first given its present name by Ludwig (25) in 1881, when the Synaptid was no longer placed in the genus Holothuria.

Nevertheless a species described by Lesseur in 1824 had already been named *H. maculata*, a name which strictly should still stand. Since, however, Lesseur's description is too imperfect for purposes of identification, and since, moreover, the name *maculata* has been given to the species under discussion by most authors of recent years, the name has become established, and I do not propose to use Semper's synonym *arenicola* in place of the now almost universally accepted name *maculata*.

Five specimens of this species collected by Mr. Cyril Crossland at Suez, differ somewhat from the recognized form. The two rows of dark patches are absent from the bivium, but at each extremity there is a well-defined area in which the ground colour is black and the appendages are light yellow. The

general colour is auburn; and the appendages appear to be more numerous and larger than in typical specimens. Internally they show no points of interest. The deposits differ slightly from typical forms in that the disc of the table is frequently much reduced and the holes of the buttons are extremely small.

Holothuria maculata burrows in the sand between tide-marks.

HOLOTHURIA RUGOSA, Ludwig.

(Plate XII., fig. 19.)

Holothuria rugosa, Ludwig 1875 (23), 1882 (26); Lampert 1885 (19); Théel 1886 (42); Bedford 1898 (2); Koehler & Vaney 1908 (7).

? *Holothuria triremis*, Sluiter 1901 (41).

One specimen, obtained by Mr. J. Stanley Gardiner in the Maldives.

External Characters.—Length 85 mm., breadth 20 mm. The colour in spirit is yellowish-brown. There are papillæ on the bivium and true pedicels on the trivium. In the specimen examined by me all the papillæ are closely retracted, but the pedicels are still half expanded. The pedicels are arranged in three distinct rows on the trivium. The central row is clearly double, and the lateral rows are single, although in some parts, probably owing to contraction, the lateral rows are zig-zag and thus appear double. A close inspection with a lens shows that the papillæ are arranged in six irregular rows on the bivium, but with the naked eye very few papillæ can be seen.

Internal Structure.—The calcareous ring agrees with Ludwig's drawings of the species, and it also resembles that of *Mesothuria murrayi*, Théel, a resemblance which is also seen in the case of the spicules. But *Mesothuria murrayi* differs in many respects from the above species, and is undoubtedly not identical with it. The tentacles are absent in the specimen from the Maldives, as are also the principal internal organs.

Spicules.—The deposits consist of tables and buttons. The tables consist of a disc 90 μ in diameter consisting of a central hole and a dozen or more peripheral holes. In the most complete form the tables bear long spines on the edge of the disc. There is a well-developed tower having a height of 65 μ, and consisting generally of four uprights which converge towards the summit of the tower, and which are joined together by a cross-piece. These supports bear spines about half-way up. The top of the tower bears a number of long spines, some of them 50 μ in length, which radiate outwards from the centre. Many of the tables show signs of disintegration. Frequently the spines on the outside of the disc and on the top of the tower are either absent or very much reduced, and sometimes the disc is so much reduced that instead of a circle of holes there is merely a serrated border.

In the Maldives specimen the buttons are extremely scarce, and are apparently only present in and about the pedicels and papillæ, but in a specimen from the Indian Museum the buttons are evenly scattered. It is possible that the buttons, which are extremely delicate, have been dissolved out of the Maldives specimen through the action of formalin, since most of the tables are much reduced. The buttons are irregular, and generally have four or more pairs of holes, but the buttons are frequently asymmetrical in regard to the number of holes.

Remarks.—So far as I can judge from the descriptions it would appear that *H. triremis*, Sluiter (46), is identical with Ludwig's species, although there are some differences in the two accounts. The Maldives specimen appears to link up Ludwig's and Sluiter's specimens. Ludwig's single specimen was light yellow, and had twenty yellow tentacles. The body was marked by five radial ridges and by several transverse wrinkles, probably due to ante-mortem contractions. The trivium bore numerous pedicels and the bivium less numerous papillæ. Sluiter's specimens were reddish-brown colour and had twenty brownish-voilet tentacles. The pedicels were arranged in three distinct double rows on the trivium, and the numerous papillæ stood on conical warts and were irregularly arranged. It is with regard to the spicules that the two

species show great similarity, and they agree in the main with the description I have given above.

Sluiter's figure of the tables differs from Ludwig's, in that the supports of the spire are parallel. In Ludwig's they converge as they approach the summit, and there are sometimes six supports. Ludwig's specimen had the buttons aggregated around the pedicels and papillæ. In Sluiter's they appear to be evenly distributed.

In the specimen which I have before me the external characters agree more with Sluiter's species, since the tube feet are arranged in three distinct rows, but it resembles Ludwig's specimen in the form of the calcareous ring and the deposits.

General Distribution.—An uncommon form, confined to the Indo-Pacific littoral regions.

HOLOTHURIA DISCREPANS, Semper.

(Plate XII., fig. 20.)

Holothuria discrepans, Semper 1868 (38); Lampert 1885 (19); Théel 1886 (42).

One specimen, obtained by Professor J. Stanley Gardiner in the Maldives. The specimen is very small, being only 20 mm. long. The only other specimens known are two described by Semper (38) from Samoa.

External Characters.—The colour of the small spirit specimen is yellow below. On the bivium there are a few yellow circles around the papillæ and there are several narrow bluish-black transverse bands across the bivium. The trivium bears yellow pedicels which are arranged in three distinct rows, the two outer rows being double and the central row having four sets of pedicels. Semper does not describe the arrangement of the tube-feet. It is possible that in this species, as in many others, the tube-feet are arranged in rows in the young specimens only. There are a few papillæ irregularly scattered over the bivium. According to Semper there are thirty tentacles. Owing to the minute size of the specimen under examination I cannot confirm this.

Internal Structure.—The calcareous ring is of the usual type. I am unable to detect the Polian vesicle and stone canal, but Semper describes the presence of the Polian vesicle and one stone canal. Cuvierian organs are present.

Spicules.—These consist of tables in the general integument, and according to Semper smooth buttons with three pairs of holes around the base of the ambulacral appendages. There are also elongated perforated plates supporting the appendages. The tables measure 44 μ across the disc. The disc has typically a large cross-shaped hole in the centre, four parts of which reach the periphery, and alternating with these are four smaller holes. The disc is subject to variation in regard to this. When the tower is complete, which is rare, it is surmounted by a square top which bears several spines, the four largest being placed one at each corner. The tower is low, being only about 25 μ in height, and seems to have a variable number of supports. The perforated supporting rods of pedicels are 80 μ or more in length. They are very broad in the middle and bulge slightly at each end.

Distribution.—Samoa and Maldives. Only three specimens of this species are known. The first two were described from Samoa in 1868, and the other specimen was not obtained until thirty years later from the Maldives. Considering the great distance between these two localities it is surprising that no specimens have been recorded from intermediate stations during a period of thirty years.

HOLOTHURIA IMPATIENS (Forskaal).

(Plate XIII., fig. 21.)

Fistularia impatiens, Forskaal 1775.

Trepang impatiens, Jäger 1833 (14).

Holothuria fulva, Quoy & Gaimard 1833 (36).

Thyone impatiens, Blainville 1834.

Sporadipus impatiens, Grube 1840.

Holothuria botellus, Selenka 1867 (37); Semper 1868 (38).

Holothuria impatiens, Semper 1868 (38); Ludwig 1875 (23), 1887 (29), 1888 (30), 1899 (32); Lampert 1885 (19), 1889 (20), 1896 (21); Théel 1886 (42); Bell 1887 (6), 1889 (7); Sluiter 1887 (39), 1910 (41); Herouard 1893 (13); Koehler 1895 (15); Bedford 1899 (3); Koningsberger 1904 (18); Fisher 1907 (11); Koehler & Vaney 1908 (17); Pearson 1910 (34) (35).

External Appearance.—The body is covered with papillæ only, no true pedicels being present. These are situated upon conical eminences, which give a characteristically papillated appearance to the body. The papillæ are irregularly disposed, and appear to be equally abundant upon the bivium and trivium. The colour of the body is brown, punctated with numerous minute dark brown spots. Some of the dorsal papillæ are dark brown, others a light brown. There is often a series of purplish-brown transverse stripes across the back, those in front being regular, but becoming more irregular towards the posterior end of the body. Thus the back of the animal presents a variegated appearance. The body when extended is very long in proportion to its width, and in a living example measured by me the length was 275 mm. and the width 25 mm. There are 20 light yellow tentacles, and the anus is surrounded by a rim of small papillæ.

Internal Structure.—The internal structure calls for no special remarks. The Cuvierian organs are double, and extremely large. The left respiratory tree extends to the anterior end of the body, but is extremely slender; the right respiratory tree, on the other hand, is short but massive.

Spicules.—The calcareous deposits consist of tables and smooth buttons. The tables are characteristic, and consist of a fairly square base, consisting of nine almost equal holes forming rows of three. The base has a diameter of 90 μ. The tables are 75 μ high and generally have one cross-beam, but there may exceptionally be two. The tower is surmounted by about 20 spines. The buttons are 75 μ in length and have six holes.

General Distribution.—This is a common form in the tropical and sub-tropical waters of the Indo-Pacific region. It has also been recorded from Florida.

HOLOTHURIA SCABRA, Jäger.

(Plate XIII., fig. 22.)

Holothuria scabra, Jäger 1833 (14); Brandt 1835 (8); Semper 1868 (38); Haacke 1880 (12); Ludwig 1882 (26), 1883 (27); Lampert 1885 (19); Théel 1886 (42); Sluiter 1901 (41); Koningsberger 1904 (18); Koehler & Vaney 1908 (17); Pearson 1910 (34), 1910 (35).

Holothuria tigris, Selenka 1867 (37).

Holothuria cadelli, Bell 1887 (5).

Holothuria gallensis, Pearson 1903 (33).

There are numerous specimens in the collections under examination.

External Characters.—The body is comparatively short and stout. The two ends are flattened. The body is covered with minute papillæ, which are irregularly scattered and are more abundant on the trivium than on the bivium. This species probably shows greater colour-variation than any other Holothurian. The bivium may be black, black with a few yellowish-white streaks, or black with broad transverse white bands. The black may vary in intensity, and is frequently replaced by gray. The trivium is of a light yellow colour, so that there is a marked distinction between the two surfaces. On the yellow ground may be seen numerous small gray patches, which mark the position of the papillæ. Each papilla is grayish in colour and surrounded by a gray circle. In the extreme cases the gray patches join together to form an irregular mass, broken up by lighter markings. There are twenty tentacles.

Internal Structure.—The calcareous ring is normal. The Polian vesicles vary in number. In one freshly-killed specimen, 225 mm. long, there were three Polian vesicles. The first was 40 mm. long and arose in the left inter-radius of the trivium. The second was 15 mm. long and arose on the left radius of the bivium. The third was 110 mm. long and arose near the dorsal mesentery. The single stone canal is small and

sometimes difficult to find. In the specimen referred to above the stone canal was situated close to the third Polian vesicle. The left respiratory tree is larger than the right, but does not extend so far forward as the latter. No Cuvierian organs are present.

Spicules.—The spicules consist of tables and knobbed buttons. The tables are 72 μ in diameter, and have a large central hole and several smaller peripheral holes. The margin of the disc is smooth. The tower is 50 μ high and is robust. Its four uprights are connected by one tier of cross-beams, and the top is surmounted by numerous spines.

The buttons have three pairs of holes and are 50 μ long.

Holothuria spinifera, Théel.

(Plate XIII., fig. 23.)

Holothuria spinifera, Théel 1886 (42); Ludwig 1887 (29).

Only two specimens of this species have been recorded hitherto, the type of the species which was obtained by the "Challenger," near the Philippine Islands, and one specimen obtained by the Drs. Sarasin on the East Coast of Ceylon. The Colombo Museum possesses three more specimens, two of which were obtained from the Ceylon Pearl Banks by the present writer, and another without a label. One specimen measured when in an expanded condition was 350 mm. long and 65 mm. broad.

External Characters.—The body is yellowish-white on the trivium, with the exception of a light brown streak which runs longitudinally along the medium line. The dorsal surface is light brown, darker in the middle, and becoming lighter at each side. Some of the dorsal papillæ are also dark brown in colour. The ambulacral appendages are papillæ only. They are scattered irregularly over the body, those on the dorsal surface being bigger and more conical. Along each side of the body at the junction of the bivium and trivium there is a row of papillæ slightly larger than those on the back. The bivium

is well arched and the trivium is flattened. There are five groups of papillæ around the anus. There are twenty light yellow tentacles. The tentacles are surrounded by a rim of small papillæ.

Internal Structure.—The calcareous ring presents no features of importance. There is a single Polian vesicle 25 mm. long when contracted. The single stone canal is situated on the right side of the dorsal mesentery. As Théel has pointed out, it is of extraordinary length, being 35 mm. long in the specimen of which the measurements are given above. The right respiratory tree is larger than the left. In the specimens examined by me there are no Cuvierian organs.

Deposits.—These agree generally with Théel's description. They consist of tables and knobbed buttons in the general integument. The disc of the table is rounded and has a diameter of 90 μ, and is perforated irregularly by a number of small holes. Sometimes there is a central hole surrounded by a number of peripheral holes. The under surface of the disc is not always smooth, but is sometimes complicated by the presence of irregular cross-connections. The tower is 60 μ in height, and has one cross-piece, and is surmounted by a large number of spines.

The buttons are 40 μ long and have three pairs of holes, and often show irregularities.

In the papillæ there are tables with very high towers (300 μ high) ending in a single blunt spine, and also irregular perforated plates. The high towers make the identification of this species clear.

General Distribution.—Philippines, Ceylon.

Holothuria ocellata, Jäger.

(Plate XIV., fig. 24.)

Holothuria ocellata, Jäger 1833 (14); Lampert 1885 (19); Théel 1886 (42); Koehler & Vaney 1908 (17); Pearson 1910 (35).

One specimen from the Indian Museum, length 120 mm., breadth 55 mm.

External Appearance.—The spirit specimen has a yellowish-white ground colour. Numerous small brown spots are scattered over the integument, but they are too small to detect without the aid of a hand lens, except in the middle of the trivium and irregularly on the bivium, where they are much more crowded and produce brown markings. Most of the papillæ on the bivium are of a chocolate-brown colour, thus standing well out upon the lighter background. I cannot see the double circular ring around the papillæ which Théel described. The ambulacral appendages consist of papillæ only, which, as in *Holothuria spinifera*, remain extended to a considerable extent in the preserved specimen. The papillæ are slightly smaller and more numerous on the trivium. The largest papillæ are found along each side of the body, as in *Holothuria spinifera*.

Internal Structure.—The calcareous ring is well formed and the radial pieces are massive. I have found only one Polian vesicle. Théel records seven from the "Challenger" specimen, but this difference is not of importance. It is interesting to note that the stone canal is very similar to that of *H. spinifera*, both in its position and large size. Both branches of the respiratory tree extend to the anterior end of the body, but the left branch is the larger. Cuvierian organs are present.

Spicules.—These consist of tables and knobbed buttons. The discs of the table differ slightly from Théel's drawings, in that they often have more holes and the edge of the disc is more irregular. The disc has a diameter of 100 μ, and generally contains a large central hole surrounded by smaller holes, but occasionally the disc is irregularly perforated and contains numerous small holes instead of the single central hole. The buttons are 65 μ long and have three pairs of holes. In the papillæ there are a few tables of the usual type, and a large number of massive rods perforated at each end, and having a flattened perforated centre.

General Distribution.—Indian Ocean.

Remarks.—This species is undoubtedly related to *H. spinifera*. The external differences are not very great, the colouring of *H. ocellata* being generally more decided than that of *H. spinifera*. The disposition of the papillæ is the

same in both species, but the large lateral papillæ of *H. ocellata* are larger than those of *H. spinifera*. The spicules of both species belong to the same general type. There is evidently much variation in the tables of the two species, and the tables of the Ceylon specimens of *H. spinifera* agree almost as well with Théel's drawings of *ocellata* as with those of *spinifera*. The latter, however, differs from the former in having tables bearing large spine-like towers in the papillæ. Also the buttons of *ocellata* are larger than those of *spinifera*. Internally there does not appear to be much difference. The calcareous ring presents some small points of difference, but both species agree in having an extremely large stone canal.

There are two small Holothurians from the Seychelles sent by Professor Stanley Gardiner, the largest being only 40 mm. in length. These two specimens agree very closely with *H. ocellata* in external appearance, in the form of the calcareous ring, and in the curious large stone canal. The tentacles and the greater part of the alimentary canal are absent from both specimens. Nevertheless they differ considerably in the nature of the spicules, and I have had some difficulty in deciding upon the identity of the two specimens. The spicules consist of tables and buttons. The tables are of two sizes, smaller tables not unlike those of a typical *H. ocellata*, forming a superficial larger, and longer tables, apparently situated at a lower level. These larger tables generally have a complete circular disc, but often it is incomplete, and forms a cross-shaped base to the table as in *H. kurti* (see Pearson, 33).

The discs of the smaller tables have a diameter of 100 μ, and are pierced by twenty or more holes and have an undulating margin. The larger tables are not very common. The disc has a diameter of about 250 μ and contains a very large number of holes. Both kinds of tables have towers similar to those found in the typical deposits of *H. ocellata*. The buttons are delicate and have about seven pairs of holes. Many of the buttons are apparently knobbed. Although the spicules are somewhat similar to those of *H. kurti*, I am confident that this form does not belong to that species. The discs and towers of the tables of *H. kurti* are much more robust than those of the specimens under examination.

I am inclined to believe that the specimens are young forms of *H. ocellata*, and the differences in the spicules are probably due to the fact that as the animal grows older the spicules become smaller owing to disintegration. This has been observed in other species by Mitsukuri and the present writer.

HOLOTHURIA MARTENSII, Semper.

(Plate XIV., fig. 25.)

Holothuria martensii, Semper 1868 (38); Ludwig 1882 (26); Lampert 1885 (19); Théel 1886 (42); Pearson 1910 (34).

A few specimens from the Australian and American Museums.

External Characters.—The preserved specimens I have been able to examine have exactly the same appearance as *Holothuria spinifera*, but as I have only examined living specimens of the latter and not of the former, I cannot say whether the resemblance is as close during life. The colour of a specimen preserved in spirit is a uniform yellowish-white both above and below. The body is covered with papillæ, which are larger along each side of the body than elsewhere.

Internal Structure.—Internally the resemblance with *Holothuria spinifera* is maintained. The calcareous ring is similar in shape and size. There is a single long Polian vesicle and a very large stone canal similar to that already described in *H. spinifera* and *H. ocellata*, the only difference being that the free end is pear-shaped as in the specimen described by Théel. Both Semper and Lampert have described the presence of two Polian vesicles and one extremely small stone canal. In specimens examined by me the stone canal is large in every case, and there is only one Polian vesicle. On these points I am in agreement with Théel. It would seem as though Semper and Lampert had mistaken the stone canal for a Polian vesicle, to which it offers a distinct resemblance. Such being the case it is difficult to know what structure they have interpreted as "der Steinkanal ausserst klein." The right

branch of the respiratory tree is larger than the left. There are Cuvierian organs present, in which character this species agrees with *Holothuria ocellata*. Cuvierian organs have not yet been recorded in *Holothuria spinifera*.

Spicules.—These consist of massive tables and knobbed buttons. The buttons are the same as those of the other two related species, but the tables are different. The tables are characterized by having extremely high towers, each consisting of four uprights and about eight cross-pieces. The tower is surmounted by numerous teeth. Height of tower 125 μ. The disc of the tower is perforated irregularly by about twenty or more holes and has a diameter of 120 μ. The supporting rods in the papillæ are similar to those in *Holothuria ocellata*. *Holothuria martensii* differs, therefore, from *H. ocellata* and *H. spinifera* in the nature of the tables, in the general integument, and from the latter species in having no tables bearing large spines in the papillæ.

General Distribution.—East Indies, Ceylon, and Australia.

Holothuria albiventer, Semper.

(Plate XIV., fig. 26.)

Holothuria albiventer, Semper 1868 (38) ; Lampert 1885 (19), 1895 (21) ; Théel 1886 (42) ; Hérouard 1893 (13) ; Ludwig 1899 (29) ; Sluiter 1901 (41) ; Pearson 1910 (34).

Several specimens, collected by Professor Stanley Gardiner in the Maldives.

External Characters.—The ambulacral appendages consist of papillæ only, those on the dorsal side being small and numerous, those on the ventral side being larger and less closely arranged. In the spirit specimens at my disposal the bivium is clearly marked from the trivium, not only by the disposition of the papillæ mentioned above, but also by the difference in colour. The general colour is grayish-brown, but the trivium is lighter, especially on the papillæ. In Semper's description of the living animal he gives the colour as follows :—Bivium,

greenish-brown with irregular light patches and an indefinite dark patch. The lower surface, dark gray with numerous white patches. Papillæ, on the bivium gray, those on the trivium white.

Internal Structure.—As in the three previous species the stone canal is exceptionally large, and arises from the right side of the dorsal mesentery. There is a single Polian vesicle. The stone canal is similar to that of the three previous forms. Cuvierian organs are evidently not present in this species, since they are not mentioned by previous writers, and there are none present in the specimens under examination.

Spicules.—These are very characteristic, and consist of tables and knobbed buttons in the general integument. The knobbed buttons have the usual three pairs of holes and are 40 μ in length. The tables are peculiar in that the tower is supported by numerous uprights. The base of the tower is perforated irregularly and is 90 μ in diameter. The height of the tower is 85 μ, and the top is surmounted by numerous spines.

General Distribution.—Indian Ocean, particularly common along the east coast of Africa.

Remarks.—Hérouard (13) expressed the opinion that *H. aculeata*, Semper, together with *H. bowensis*, Ludw., and *H. modesta*, Ludw., should be included in *H. albiventer*, Semper. Ludwig, Lampert, and Sluiter have rightly shown that *H. albiventer* differs from all these species in the form of its massive tables. Since the four species described above—namely, *Holothuria spinifera*, *Holothuria ocellata*, *Holothuria martensii*, and *Holothuria albiventer*—show such close relationship in many respects I append a key to the four species :—

Common characters.—Ambulacral appendages papillæ only, which are situated upon non-contractile eminences. Extremely large stone canal arising from the right side of the dorsal mesentery.

(1) Tables in general integument having more than four upright supports. Papillæ along both sides of body not larger than rest.
.... *H. albiventer.*

(2) Tables having only four upright supports. Papillæ along sides of body larger than rest.

(A) Tables in papillæ having large spine-like superstructure.

.... *H. spinifera.*

(B) Absence of large spine-like towers in papillæ.

(*a*) Tables in general integument short and having only one transverse bar.

.... *H. ocellata.*

(*b*) Tables in general integument high and having four or more transverse bars.

.... *H. martensii.*

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Explanation of Plates.

Plate V.

Holothuria hamata, n. sp., from the dorsal side. × 1.

Plate VI.

Holothuria hamata, n. sp.
Fig. *2a*.—View of table from below. × 600.
Fig. *2b*.—Side view of table. × 600.
Figs. *2c*, *2d*.—Knobbed buttons. × 600.
Fig. *2e*.—Calcareous ring. × 4½.

Holothuria maculosa, n. sp.
Fig. *3a*.—View of table from below. × 500.
Fig. *3b*.—Side view of table. × 500.
Fig. *3c*.—View of table from above. × 300.
Fig. *3d*.—Knobbed button. × 500.
Fig. *3e*.—Spicules in neighbourhood of papillæ. × 500.
Fig. *3f*.—Perforated rods from the papillæ. × 500.
Fig. *3g*.—Calcareous ring. × 4.

Plate VII.

Holothuria marmorata (Jäger).
Figs. *4a*, *4b*, *4c*.—Typical spicules. × 1,000.
Fig. *4d*.—Spicules from the deeper hypodermis. × 1,000.
Fig. *4e*.—Calcareous ring. × 2.

Holothuria argus (Jäger).
Figs. *5a*, *5b*.—Supporting rods from pedicels. × 400.
Fig. *5c*.—H-shaped spicule from pedicel. × 500.
Figs. *5d*, *5e*, *5f*, *5g*.—Typical spicules. × 1,000.
Fig. *5h*.—Calcareous ring. × 2.

Holothuria vitiensis, Semper.
Fig. *6a*.—H-shaped spicule from pedicel. × 500.
Figs. *6b*, *6c*.—Supporting rods from pedicels. × 500.
Figs. *6d*, *6e*, *6f*.—Typical spicules. × 1,000.
Fig. *6g*.—Calcareous ring. × 2.

Plate VIII.

Holothuria graffei, Semper.
Figs. *7a*, *7b*, *7c*.—Spicules. × 1,000.
Fig. *7d*.—Spicule. × 750.
Fig. *7e*.—Calcareous ring. × 2.

Holothuria glaberrima, Selenka.
Figs. *8a*, *8b*, *8c*.—Spicules. × 600.
Fig. *8d*.—Calcareous ring. × 8.

Holothuria lubrica, Selenka.
Fig. *9a*.—Calcareous ring. × 3.
Figs. *9b*, *9c*, *9d*.—Spicules. × 450.

Plate IX.

Holothuria cinerascens (Brandt).
Figs. 10*a*, 10*b*, 10*c*.—Various views of tables. × 500.
Fig. 10*d*.—Calcareous ring. × 4.
Fig. 10*e*.—Rod-shaped spicule. × 400.

Holothuria atra, Jäger.
Figs. 11*a*, 11*b*, 11*c*.—Various views of tables. × 650.
Fig. 11*d*.—Calcareous ring. × 3.
Fig. 11*e*.—Perforated plate. × 650.

Holothuria edulis, Lesson.
Figs. 12*a*, 12*b*.—Tables. × 650.
Fig 12*c*.—Perforated plate. × 650.
Fig. 12*d*.—Calcareous ring. × 6.

Plate X.

Holothuria monacaria (Lesson).
Figs. 13*a*, 13*b*.—Tables. × 750.
Fig. 13*c*.—Button. × 750.
Fig. 13*d*.—Calcareous ring. × 7.

Holothuria vagabunda, Selenka.
Figs. 14*a*, 14*b*.—Tables. × 1,000.
Fig. 14*c*.—Button. × 750.
Fig. 14*d*.—Calcareous ring. × 6.

Holothuria fusco-cinerea, Jäger.
Fig. 15*a*.—Calcareous ring. × [illegible]
Fig. 15*b*.—Table. × 750.
Figs. 15*c*, 15*d*, 15*e*.—Buttons. × [illegible].

Plate XI.

Holothuria fusco-rubra, Théel.
Fig. 16*a*.—Table. × 1,000.
Figs. 16*b*, 16*c*, 16*d*.—Buttons. × 1,000.
Fig. 16*e*.—Calcareous ring. × 6.

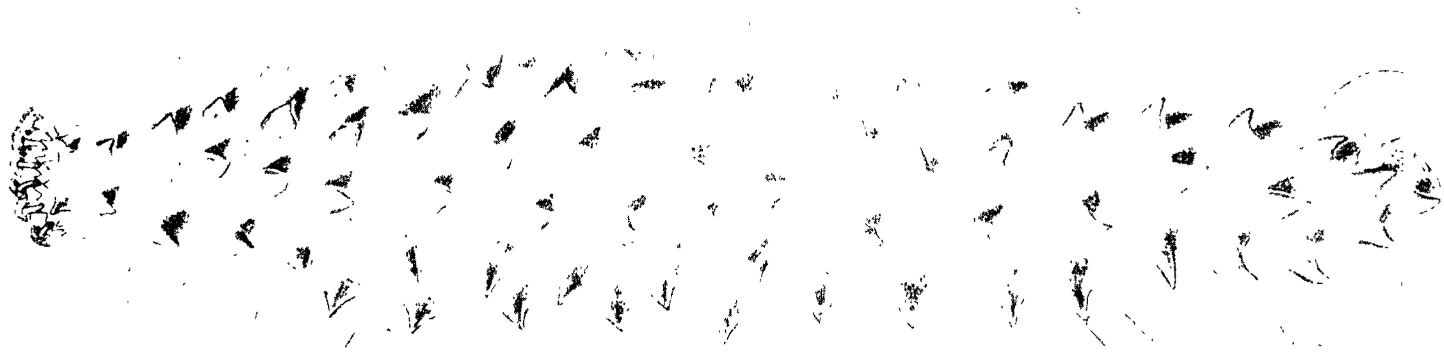
Holothuria pardalis, Selenka.
Figs. 17*a*, 17*b*.—Tables. × 500.
Figs. 17*c*, 17*d*, 17*e*.—Buttons. × 500.
Fig. 17*f*.—Calcareous ring. × 7.

Holothuria maculata (Brandt).
Figs. 18*a*, 18*b*, 18*c*.—Tables. × 400.
Fig. 18*d*.—Button. × 400.
Fig. 18*e*.—Calcareous ring. × 3½.

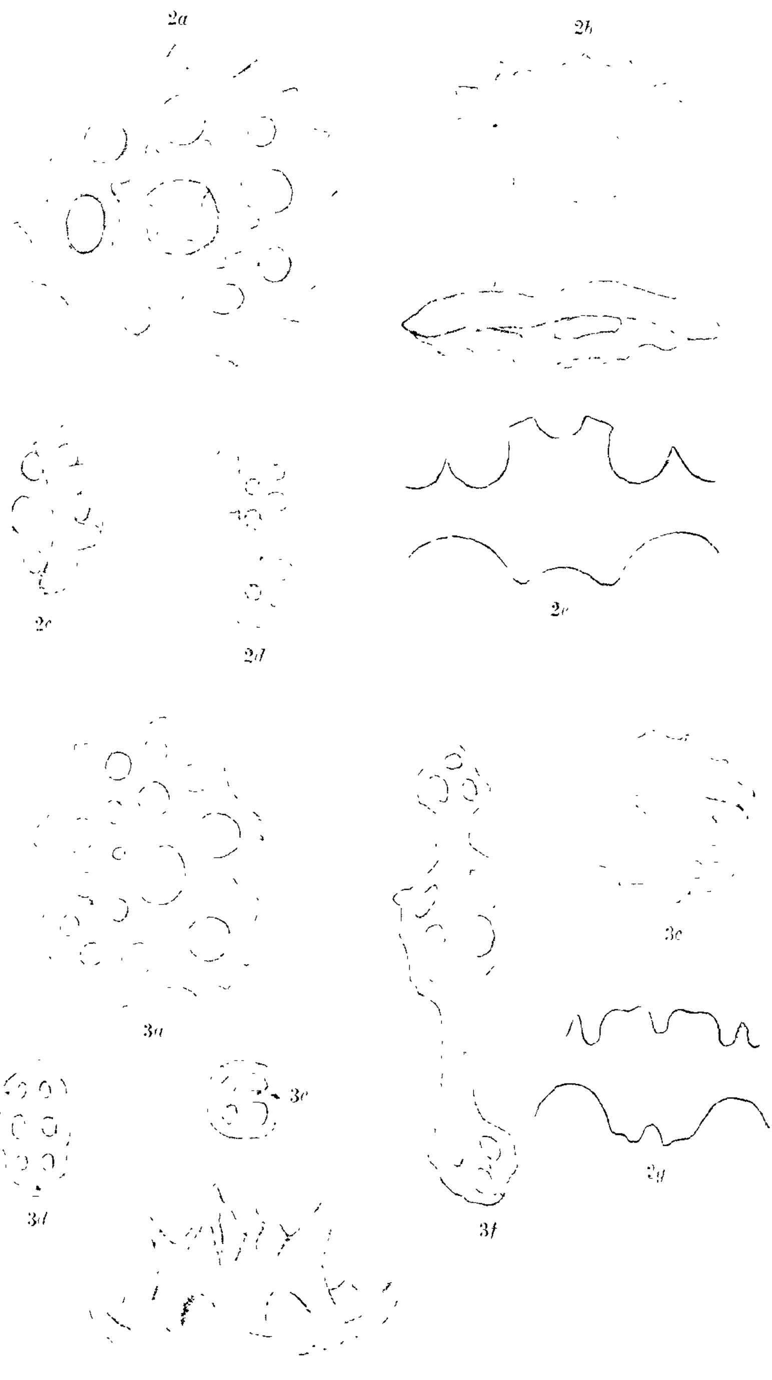
Plate XII.

Holothuria rugosa, Ludwig.
Figs. 19*a*, 19*b*, 19*c*.—Tables. × 550.
Figs. 19*d*, 19*e*, 19*f*.—Buttons. × 550.
Fig. 19*g*.—Calcareous ring. × 6.

Holothuria discrepans, Semper.
Figs. 20*a*, 20*b*.—Tables. × 900.
Fig. 20*c*.—Button. × 900.
Fig. 20*d*.—Calcareous ring. × 12.

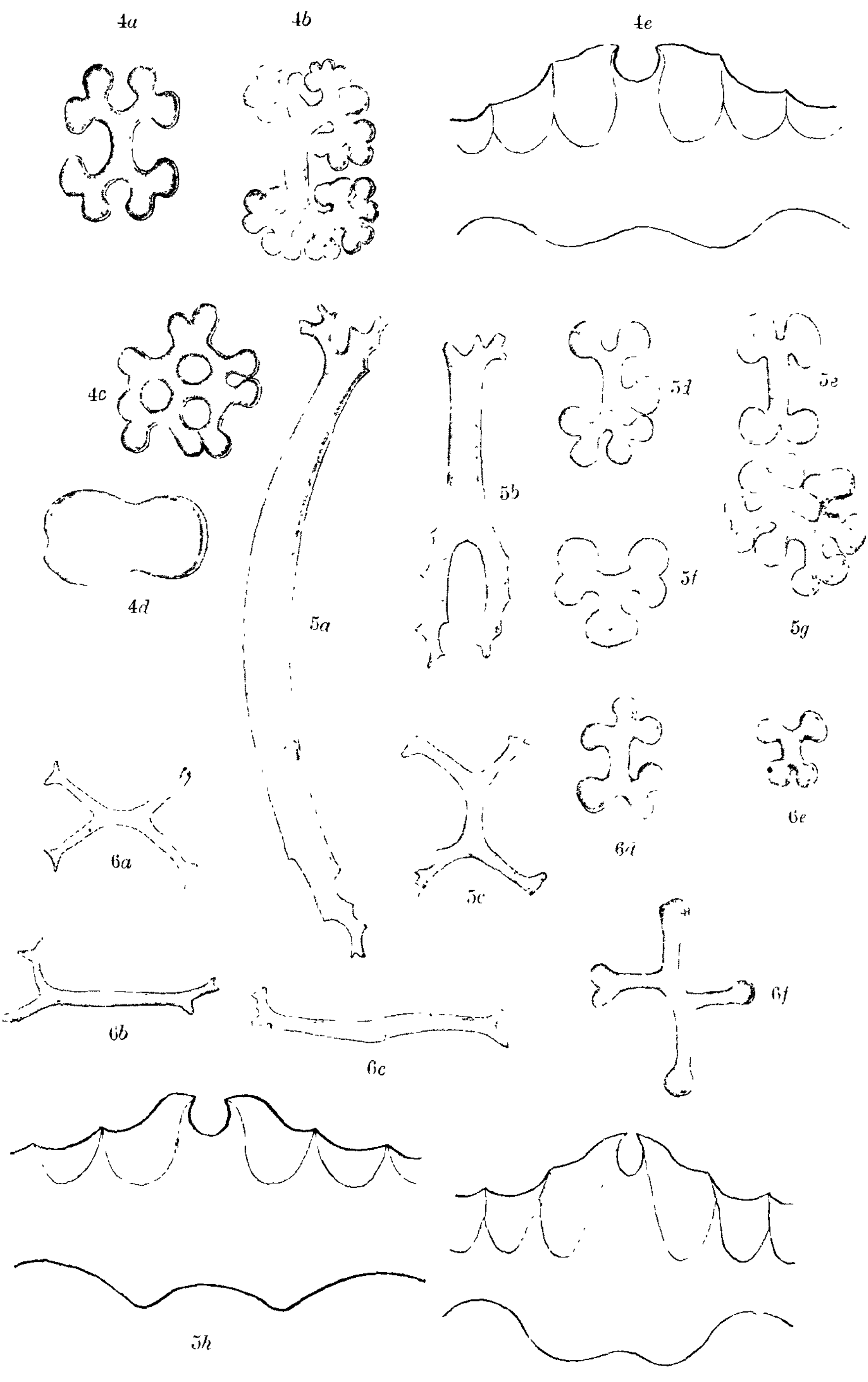


Holothuria hamata, n. sp.



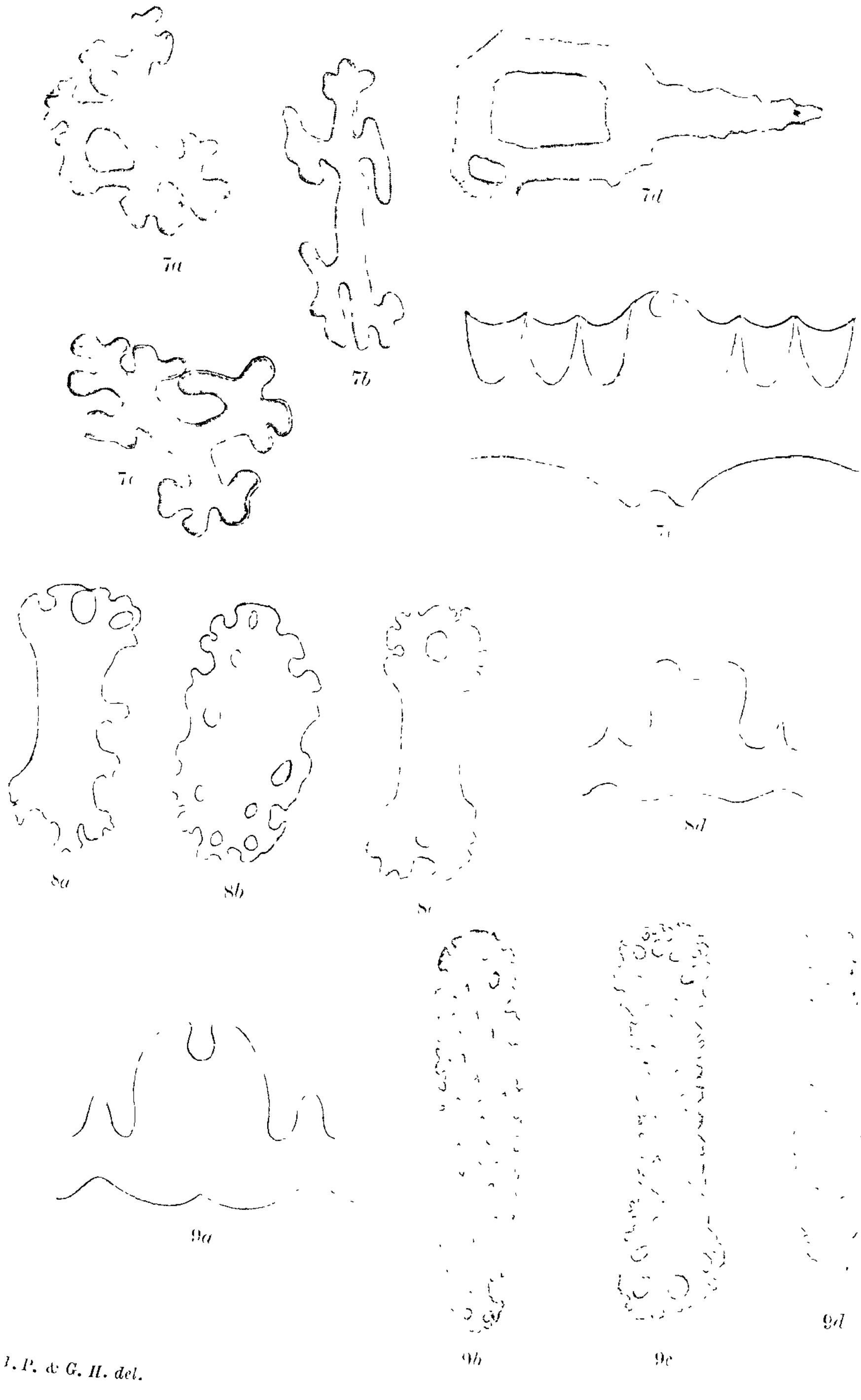
J. P. & G. H. del.

FIG. 2.—HOLOTHURIA HAMATA, n. sp. FIG. 3.—HOLOTHURIA MACULOSA, n. sp.



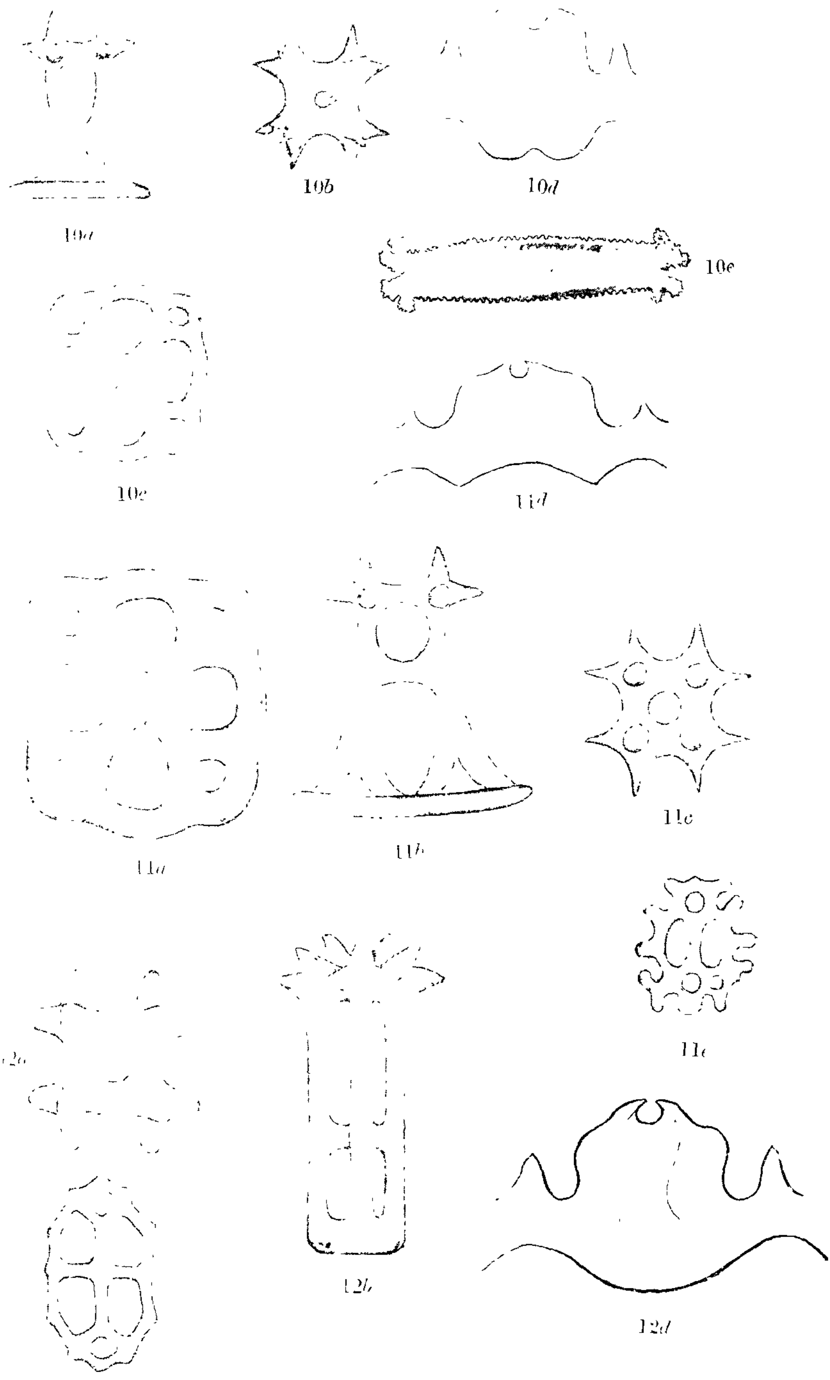
J P. & G. H. del.

FIG. 4.—H. MARMORATA. FIG 5.—H. ARGUS. FIG 6—H VITIENSIS



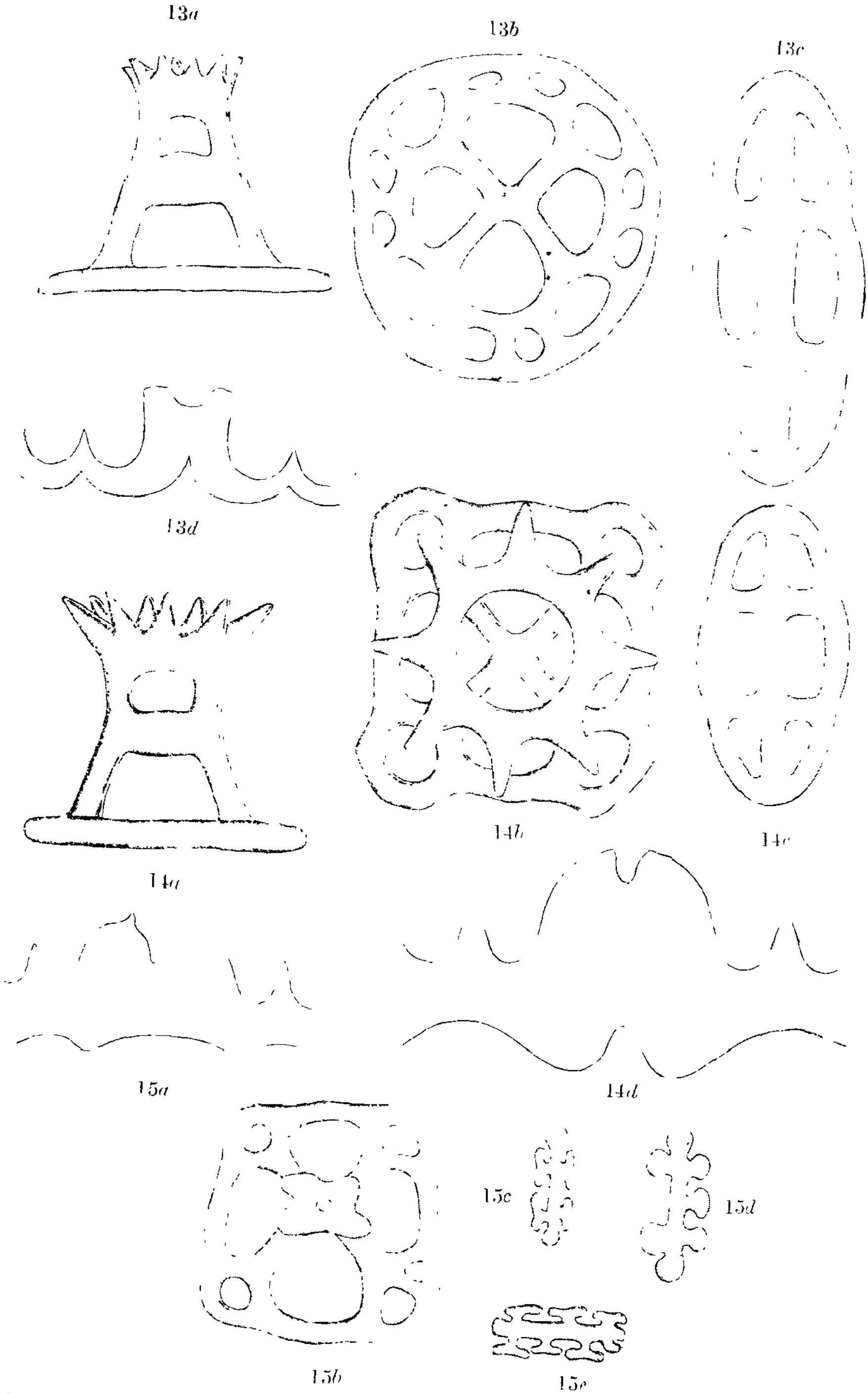
I. P. & G. H. del.

Fig. 7.—H. graffei. Fig. 8.—H. glaberrima. Fig. 9.—H. lubrica.



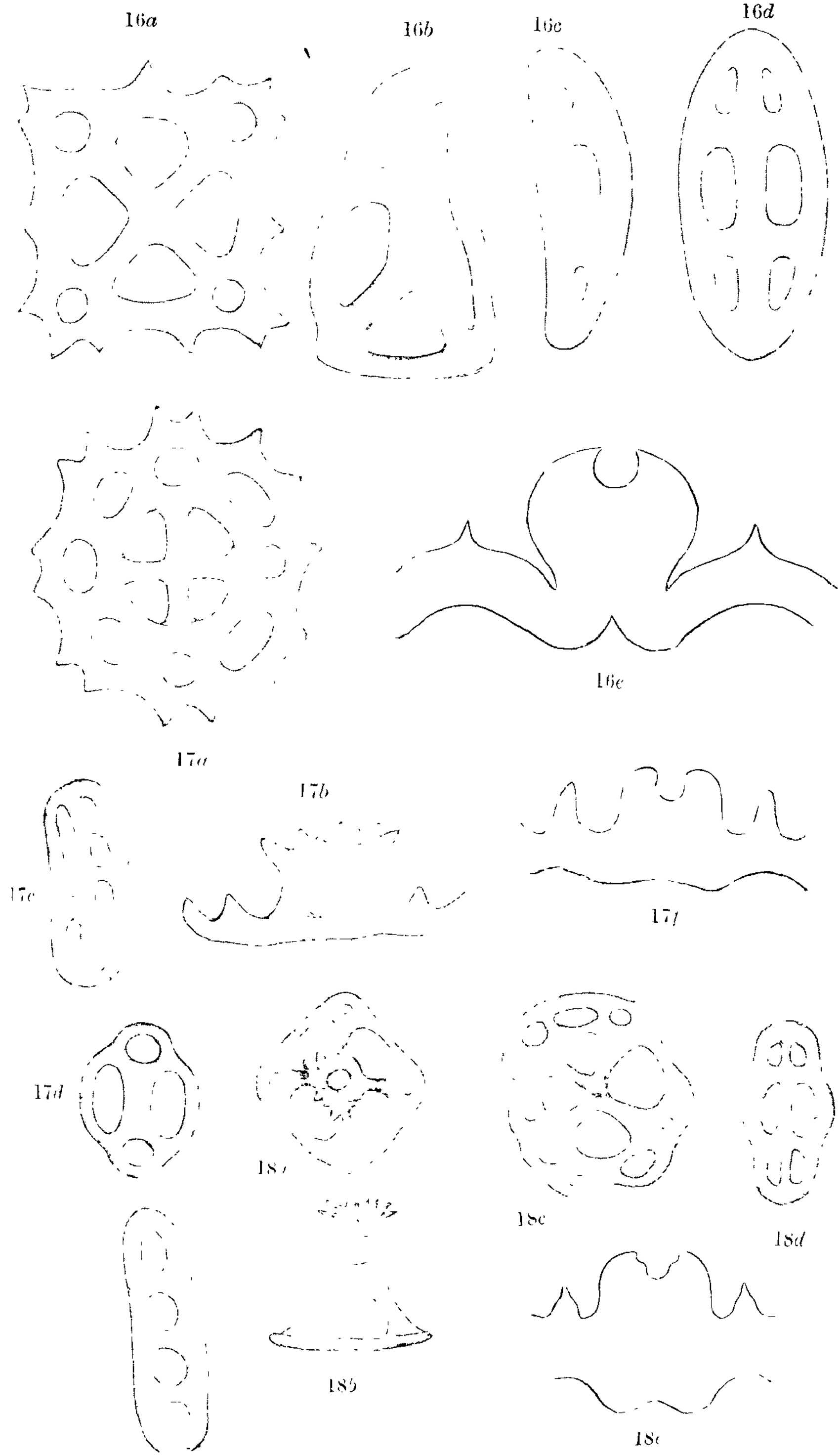
P. & G. H. del.

FIG. 10.—H. CINERASCENS. FIG. 11.—H. ATRA. FIG. 12.—H. EDULIS.



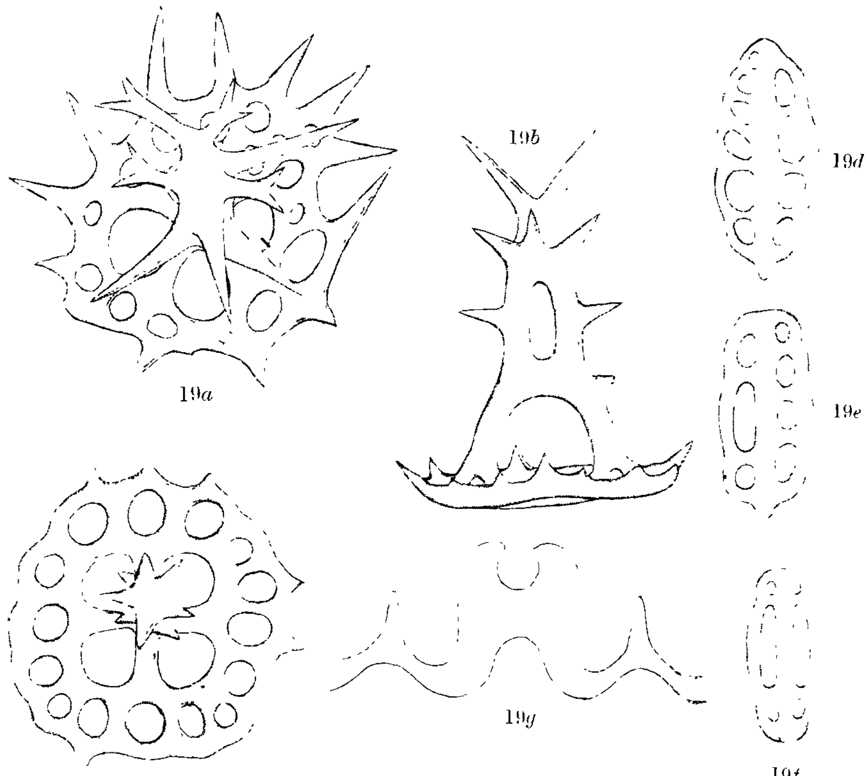
J. P. & G. H. del

FIG. 13.—H. MONACARIA. FIG. 14.—H. VAGABUNDA. FIG. 15.—H. FUSCO-CINEREA.



J. P. & G. H. del.

FIG. 16.—H. FUSCO-RUBRA. FIG. 17.—H. PARDALIS. FIG. 18.—H. MACULATA.



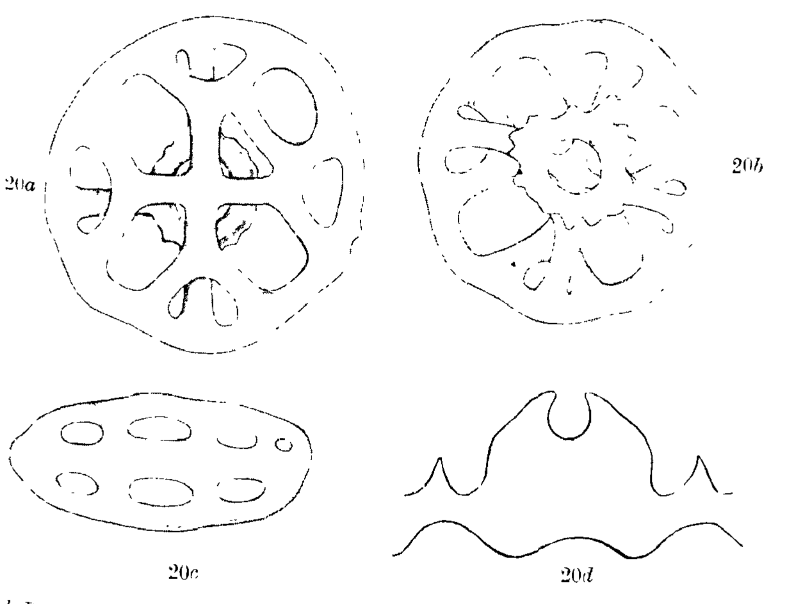


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FIG. 19.—H. RUGOSA.

FIG. 20.—H. DISCREPANS.

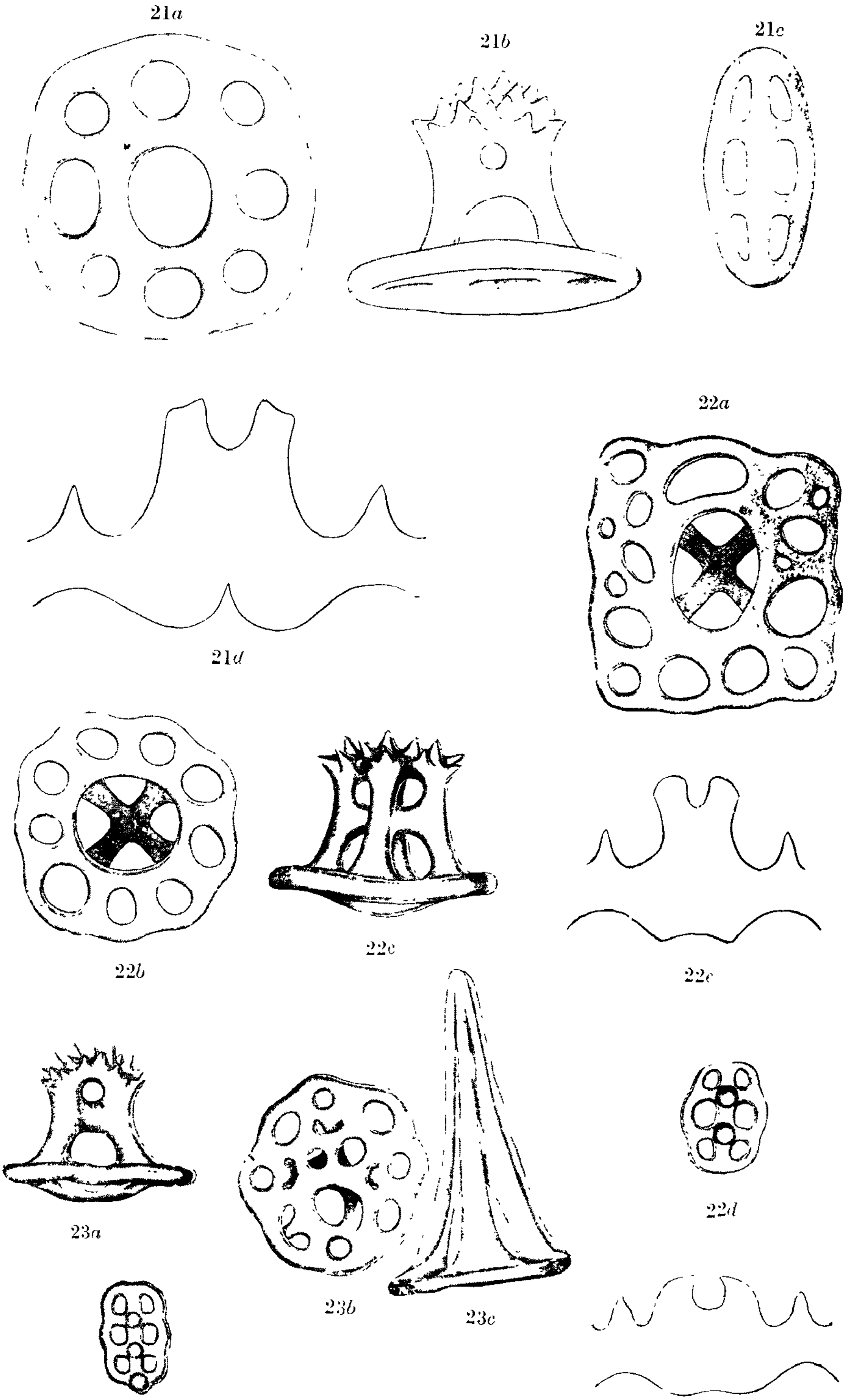

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FIG. 21.—H. IMPATIENS. FIG. 22.—H. SCABRA. FIG. 23.—H. SPINIFERA.

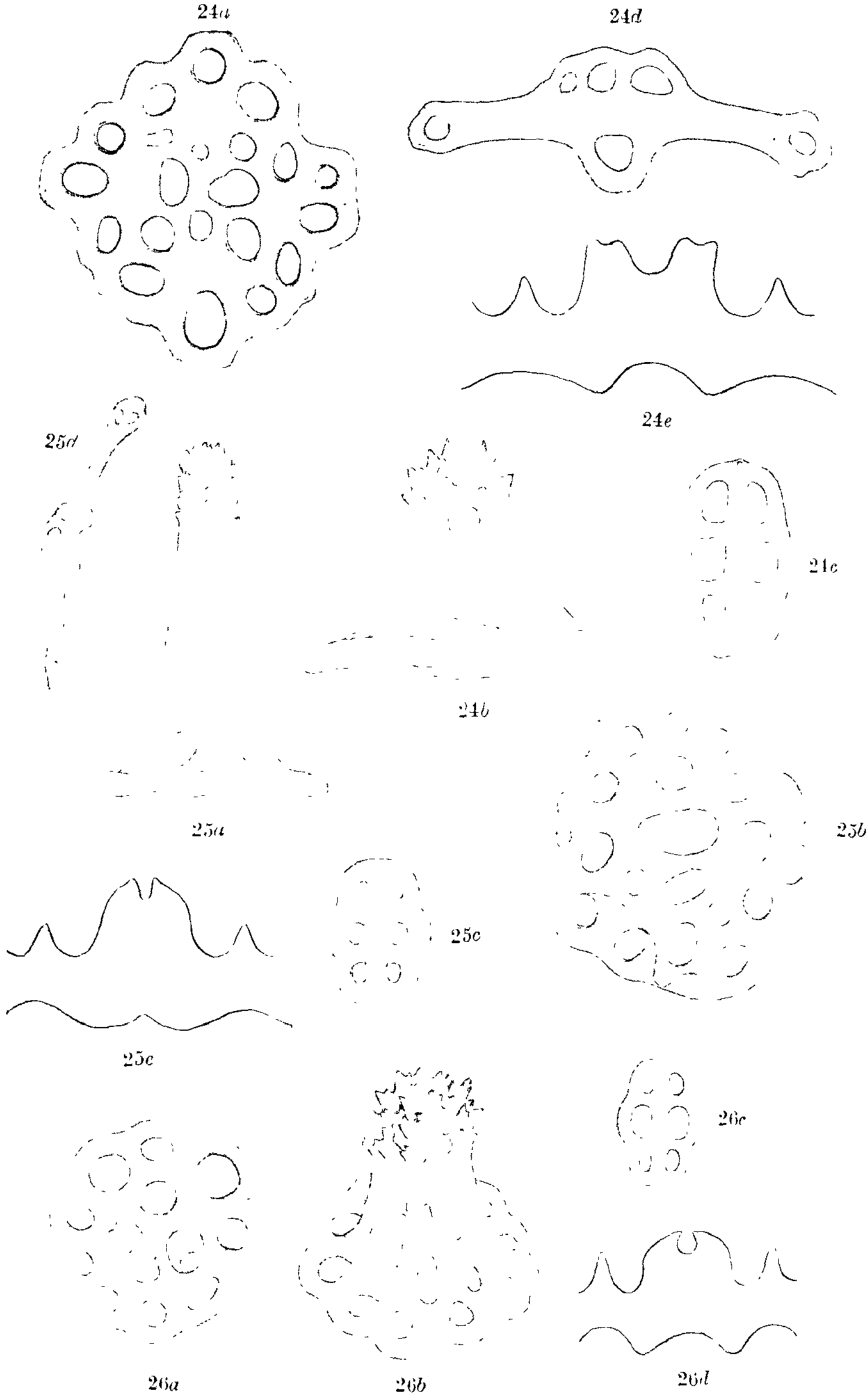

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FIG. 24.—H. OCELLATA. FIG. 25.—H. MARTENSII. FIG. 26.—H. ALBIVENTER.

NOTES ON SOME TERMITES FROM CEYLON.

By Oscar John,

St. Petersburg, Russia.

DURING the months of November and December of last year (1912) I collected termites in Ceylon, chiefly at Peradeniya, and had occasion to make some observations on the habits of certain species.

Much work upon the termite fauna of Ceylon has been accomplished, but more still remains to be done. I hope, therefore, that the publication of my notes, though incomplete and fragmentary, may be of some use to future workers.

Before proceeding, I beg to express my warmest thanks to Mr. E. E. Green, whose kind help and directions, based on a vast knowledge of the Ceylon fauna, were quite invaluable to me.

Termes horni, Wasm.

When returning, on December 12, from a stroll to the lake of Kurunegala—it had just begun to grow dark—my attention was attracted by a large number of bats flying along a short thoroughfare. The cause of this gathering of bats became evident when I saw a cloud of large-winged termites rising from under a hedge bordering the road. Unfortunately it was already too dark to determine the exact point of exit of the termites ; but all the grass over a rather large space of ground seemed to be alive with a vast number of them, crawling up from some openings in the earth and flapping their wings to start for flight. This produced a distinctly audible, I may even say a rather loud, noise. Trying to find out the places from which the termites emerged, I struck some matches, but by their feeble light, which moreover was almost immediately extinguished by the wind, all I could see was that in two places, about a yard or so apart, large crowds of workers

and soldiers were congregated. But it seemed to me that the winged individuals were emerging not only from these two places, but also between and beyond them. In those gatherings the worker caste seemed to be far predominant, as I found about a dozen soldiers only amongst a large number that I swept into a tin, whereas the number of workers exceeded two hundred.

The next morning I examined the place, but could find no signs of the presence of *T. horni*, except some shed wings. Neither could I discover the openings from which they had made their exit the night before, nor did I find any traces of them or of their nest in the neighbourhood.

I have thought it worth while to describe this exodus of *T. horni*, incomplete as my observations are, because this phenomenon has been observed very seldom, and all we have to go upon is Mr. Petch's account of three such events observed by him in relation to *T. obscuriceps* and *T. redemanni*.

ANOPLOTERMES CYCLOPS, Wasm.

Our knowledge of this species is very incomplete. All we know is that, in common with the other species of the genus, it is distinguished by the absence of the soldier caste, and that it is to be found under stones and logs of wood. Habitat, Peradeniya and Maha Iluppallama.

I have found this species on four occasions : once at Kurunegala, under a stone (December 12, 1912), and three times at Peradeniya, once (December 16, 1912) in a mound of *Termes redemanni*, which *An. cyclops* shared with the host and *Capritermes incola*. The next day I found another colony, also in a nest of *redemanni ;* and on the fourth occasion (December 18, 1912) I found it in a mound of *Termes obscuriceps*, inhabited, moreover, by *Hamitermes quadriceps* and *Eutermes escherichi*. There is nothing unusual in the occurrence of *Anoplotermes* in the mounds of other species. Such an association has been already recorded by Holmgren in the case of the South American species *An. reconditus*, which occurs in the nests of *Termes dirus*.

These colonies of *An. cyclops* were dispersed over the whole mound, inhabiting small flat chambers, which were crowded with workers, larvæ, and nymphs.

Twice I succeeded in capturing the queens. In one instance I took a queen in a mound of *redemanni*; but I found as many as five queens and one king in a single *obscuriceps* mound. As the queen cell is in no way distinguished, either by its structure or its position, it is just by chance that one finds them. I found them concealed in ordinary tunnels, not crowded together, but at some distance apart. When opening the mound it is very easy to cut away a piece containing the queen or queens; and they can be easily damaged, as was the case with one of those taken by me. I cannot, therefore, be certain whether there were any more queens or kings in these colonies. The queens did not differ very much from the winged adults. Some of them had the abdomen slightly inflated, so that the intersegmental membrane was somewhat extended; others had just the appearance of the winged form—after it has shed its wings.

When captured, the workers always lifted up their abdomens after the manner of ants—*Cremastogaster* for instance—so that the anal part came right above the head, excreting at the same time a drop from the anal opening. This drop consists of a thick liquid of a brownish-gray colour, and is composed of minute vegetable and mineral particles agglutinated by some secretion. When excreting this drop—which, by the way, is not viscid and leaves no stain on the skin—the worker of *An. cyclops* does not empty the whole of the contents of the gut. When a worker is immersed in water or alcohol this material is evacuated in the form of a minute sausage from 6 to 7 mm. in length and of a diameter of about 0·5 mm. In water it loses its original shape in the course of a few minutes, becoming a small heap of earthy matter; whereas in alcohol it retains its original appearance and becomes hard and brittle.

EUTERMES RUBIDUS, Hag.

I had an opportunity of watching this species rather frequently, as there was a nest right in front of the entrance of the resthouse at Peradeniya. Every morning little piles of

earth were to be seen on the road, showing the work done overnight by *Eut. rubidus*. I noticed that one of these heaps was, as a rule, larger and higher than the others. They consisted of loosely piled earth, with, usually, a small opening on the top. Inside, they were pierced by a tunnel, which in some cases was branched. Once, on the last day of my stay at Peradeniya, I noticed a rather large pile, about three inches high, on one of the footpaths in the Botanical Gardens. This pile was conical, rounded at the top, without any hole, and cemented much more firmly than any other pile seen by me. It was not unlike one of the cones that may be observed in the early stages of the mounds of *T. obscuriceps* and *redemanni*. When opened, it was found to be crowded with workers of *Eut. rubidus*. A yard or so from this heap I found another one thrown up on the turf.

Escherich's observations on this species are here translated in extenso :—" The nest of *Eutermes rubidus* is underground, with several openings on the surface of the earth, often surrounded by small craters of earth. In the vicinity of Galle I found a nest of which the openings and the surrounding space were covered by flat, brittle, earthy crusts. When I destroyed one of these weak structures, soldiers were immediately seen to emerge, both large and small ones, *Eutermes rubidus* having two forms of soldiers which differ considerably in shape and size ; the large soldiers keeping more in the background. After the first alarm had quieted down the repairs were hastily undertaken, the soldiers ....forming a dense chain round the broken place. It is remarkable that, with few exceptions, only the small soldiers were engaged in this work, whereas the large ones had mostly retired. Was this a mere chance, or is there a differentiation of work in the two forms of soldiers ? I was unable to decide this point, owing to insufficient material for observation, although the latter eventuality does not seem to me to be unlikely.

" The building was effected in a very simple manner: between the soldiers, occasional workers came forward, holding in their mandibles small crumbs of earth, which were deposited at the edge of the building and then slightly pressed on. There was none of the abundant proctodæal or stomodæal

cement ordinarily employed by termites when building their nests, only a simple compilation of earthy particles with, very possibly, a slight admixture of saliva. This simple mode of construction accounts for the loose composition and the brittleness of these superstructures. This observation is of interest, in that it reveals a new method of building, and shows us that termites are by no means bound to one scheme, but that they are able to apply different (simple or complicated) methods, according to the purpose or requisite durability of the structure."*

I have quoted Escherich at full length, because his observations are fully corroborated by my own. I may add that I have observed *Eut. rubidus* commencing their night's work at about 6 P.M., when both forms of soldiers emerged from the opening on the surface of the road and were followed by workers, each carrying a morsel of earthy material. This latter was placed without any further cementation on the ground at a short distance from the opening. But not at all the openings was such material brought up, nor was the amount of work equal at all the openings. After dark, about two hours later, straight open galleries of from 1 to 1½ inch in length were built at some of the openings, whereas at others only a small and very low crater had been formed. I counted nine openings in all from which the termites came forth, and overground traffic—by soldiers as well as workers—was established between some of them.

The most interesting part of the observation was that from one of the holes where no building was going on at all, a vast crowd of workers, guarded by soldiers, had emerged and was feeding on the leaves of some flat-growing plants, sitting more or less motionless on the leaves. Some of the workers were seen to carry home comparatively large pieces of bark. Disturbed, as I believe, by the strong light of my acetylene lantern (though the soldiers and workers of *Eut. rubidus* are blind, it is more than probable that they have some sensation of light), a movement soon occurred among the termites, and they began hurriedly to leave their pasture and to retreat

* K. Escherich. Termitenleben auf Ceylon, 1910, pp. 133, 134.

into the opening of their tunnel. The next night, at about 9 P.M., they were again to be found on the leaves; but, on being illuminated, beat a retreat as on the previous night. They were again feeding at the same place half an hour later, thickly covering the leaves and stems of the plants. In the morning the foraging party had disappeared and the opening from which they had emerged the night before was closed, but no heap of earth was left on the surface. At the other openings larger or smaller heaps had been built, and the termites were at work upon these until about 8 A.M. This open foraging of *Eut. rubidus* is very remarkable, as *Eutermes*—with the exception of the *monoceros* group, which is, at least biologically, entirely separated from the rest—are never found in the open, but in logs, stumps, and other decaying wood, to which they lead their tunnels.

Unfortunately, it was impossible to dig open their nests, as *Eut. rubidus* selects places where they are under the protection of Road Committees or other authorities, which would look somewhat askance at anyone who might attempt to undermine the roads in search of the nests—a yet unrecorded form of adaptation!

EUTERMES ESCHERICHI, Holmgr.

Only quite recently (in 1910) this species was discovered by Escherich in a nest of *Termes obscuriceps*. He found a numerous colony (workers and solders) not far from the central part of the mound, in a separate sponge-like nest built of earth. He further states that in the same mound one of the upper comb-cavities was filled by a black carton nest, the carton being mostly cemented to the walls of the cell, which was covered with a dark "wall-paper." No inmates could be found, either in the cell or in the proper nest. "As the *Eutermes* are chiefly carton manufacturers," continues Escherich, in his account, "and as I never found such a nest in any other mound, and finally I never again came across that *Eutermes*, I consider it not improbable that this species was the builder of the carton nest, and—perhaps chased from it—settled down in another part of the mound, where, for lack of

the necessary raw material, it now built a similar edifice of earth."

On December 18 I opened a mound of *T. obscuriceps* in the Experiment Station grounds (where Escherich found his *E. escherichi*). Near the surface of the earth I found a tunnel, from which emerged a large number of soldiers of this species. Following up the tunnel, workers and a few winged individuals could be found. The tunnel led to a small by-nest inhabited by workers and soldiers. On the opposite side of the mound I found another nest, which was much larger in size than the first, *i.e.*, of the size of a man's fist. This nest contained workers, soldiers, and larvæ of different stages; but neither nymphs nor queen could be found. A third nest, of about the same size as the first, *i.e.*, of the size of a hen's egg, was close by, and, finally, I found a fourth small by-nest at some distance from the others. All of these nests were built of earthy material and contained cells of the usual *Eutermes* pattern. Strangely enough, one of the upper cavities of the mound contained, as in Escherich's case, a strange derelict structure, but this one was made of earth, and differed considerably in pattern from *Eutermes* buildings, suggesting rather, in structure, the characteristic work of *Coptotermes*.

It might be of interest to dwell a little longer on this strange *obscuriceps* nest, as it contained a considerable number of different inhabitants, and others may have been overlooked. This mound was situated at the foot of a coconut palm, side by side with a mound of *T. redemanni*. The latter was opened on the previous day and the king and queen were taken. The close vicinity of the two nests had caused a certain fusion of both, as some of the cavities of the *obscuriceps* mound were occupied by *redemanni*, which had built their combs there. Here and there, near the surface, small cavities were occupied by *Anoplotermes cyclops*, and deeper in the mound five queens and one king of this species were found. *Hamitermes quadriceps* also occurred here and there in small cells. Of other insects I can mention several colonies of species of *Camponotus* and *Cremastogaster*, an immature Gryllid, larvæ of *Orthogonius acutangulus* and of several other Coleoptera. Of *Pedipalpi*, a

very large specimen of *Phrynichus* was taken, some Myriapods, *Notoscolex termiticola* and another very large earthworm, and some *Lepismidæ.*

EUTERMES OCULATAS, Holmgr., 1911.

(= *Eutermes longicornis,* Holmgren, 1912.)

In Dr. Escherich's book entitled "Termitenleben auf Ceylon," Dr. Holmgren described this species from winged examples only, captured by Dr. Uzel at Peradeniya, suggesting that they possibly belonged to either *E. hantanæ* or *E. escherichi.* Some time later he received from Mr. E. E. Green a number of soldiers and workers of an undescribed species of *Eutermes*, which he described as *E. longicornis.*

On November 16 last I found, in a mound of *Termes obscuriceps,* a colony of *longicornis,* consisting of soldiers, workers, and winged adults. Comparing these last with the descriptions, I found them to be identical with *oculatus* of Holmgren. Therefore the name of *longicornis* must be dismissed as a synonym of the former.

The adult of this species is very conspicuous, and easily recognizable by its fontanelle of a pure white, bordered by a yellowish ring. The head is shorter than broad, with very prominent eyes. The antennæ are comparatively long, 2·6 mm., whereas in *E. ceylonicus* they measure only 1·7 mm., though both species are of about the same size and have 15-jointed antennæ. (In *ceylonicus,* the antennæ of the male have 14 joints only.) The "nasutus" soldier is recognizable from those of allied species by the length of its frontal tube, which is equal to that of the rest of the head, and very slender. This species has been recorded from Peradeniya only.

The type-material was taken by Dr. Uzel (in coll. Vienna Mus.) on November 15, 1901. I myself captured a number of winged specimens at the lights of the resthouse on November 15 and 29, 1912, and the above-mentioned colony was found on the 16th of the same month.

The types of *longicornis* were found by Mr. E. E. Green on the stem of a Giant Bamboo (*Dendrocalamus giganteus*).

EUTERMES LACUSTRIS, Bugnion, 1912.

(= *Eutermes greeni*, Holmgren, 1912).

On an excursion to the top of Hantana (a mountain of about 4,000 feet elevation, situated near Peradeniya) I discovered, in the jungle at the summit, a large tree up the stem of which a gallery was running. An inspection of the gallery proved that it emerged from the soil, ran about half-way round the base of the stem, forming there two enlargements, and then ran directly upwards. When opened, a number of termites—partly workers and partly soldiers—emerged from this gallery. The latter surprised me by the very conspicuous dark colour of their heads, a character known in but a single species of *Eutermes* from Ceylon, viz., *lacustris*. But this species had been described by Dr. Bugnion from the low-country, and Dr. Holmgren had received specimens from Mr. E. E. Green which were also collected in the low-country. These are the only records about this species. A comparison with the description and the types of Dr. Bugnion and of Dr. Holmgren proved it to be identical with *lacustris*. This identification was subsequently corroborated by Dr. Bugnion himself. Dr. Holmgren, ignorant of Dr. Bugnion's publication (June, 1912), had believed the species to be a new one and included it in his "Termitenstudien," Vol. III., under the name of *Eut. greeni*.

Some time later I ascended Hantana again, with the object of further investigating this interesting species and, if possible, of finding the nest. In this I was successful, as I first found another gallery on a tree some twenty yards distant from the first, and not very far from it the nest perched on a Ficus tree. It was rather large and built between two forking branches, some twenty-five feet up, with a gallery leading to the ground. My coolies were able to lower the nest and to transport it safely to the laboratory, with the loss only of the natural cover, which was exceedingly brittle. The dimensions of the nest were as follows :—Circumference 76 inches ; long diameter 26, short diameter 20, and height 16 inches. It was constructed in the usual *Eutermes* style, *i.e.*, the whole consisting of a system of numberless small cavities made of some woody

material and encased in a very thin outer cover to protect the nest from rain and the intrusion of ants and other predatory insects. A median section showed three more or less concentric portions. The outer area consisted of small cells, the inner of elongated cells of a much larger size, and the central portion was composed of much stronger wood-like material of a lighter colour, and containing the queen's cell and other large cells with eggs and young larvæ. This central portion was not placed in the exact geometrical centre of the nest, but considerably below the middle. This nest contained all castes, including winged adults, which were till now unknown. Dr. Bugnion has undertaken to give a description and drawings of them. After opening the nest, one-half was fixed in a tree near the laboratory, where, for some time, I was able to observe the habits of the insects.

Disregardful of daylight or even sunshine they were to be seen ascending and descending the trunk of the tree, on several tracks, and here and there appeared the beginning of a tunnel. But after a day or two only one track was used, the others being abandoned. These tracks were chiefly used by workers, but among them appeared sometimes nymphs and winged individuals. Workers now and then were seen to carry young larvæ, holding them with their mandibles. The soldiers were mostly posted in small groups on each side of the track and near the beginnings of galleries. The workers were not very eager at their work, and only a few carried small particles of building material. They deposited their tiny bricks in gaps or other suitable places, giving them the proper position by trying to place them first one way then another, finally fixing them by pressing them with a sideway movement of the head, after which I sometimes saw them turn round to place a drop of proctodœal secretion on the place.

Two weeks later, after my return to Peradeniya, I found the nest in much the same condition. The galleries were still incomplete and the nest had the appearance of being deserted. An inspection, however, showed that it was crowded with inhabitants. Possibly the position in which the nest had been placed was not a convenient one, and the loss of the queen may have upset the regular functions of the inhabitants.

The further fate of this nest is unknown to me, as I left Peradeniya soon afterwards. [It was subsequently blown down and demolished in a gale of wind.—E. E. G.]

EUTERMES MONOCEROS, Koenig.

The open "out-of-door" life of this species makes it more accessible to observation than any other termite inhabiting Ceylon, and as it is rather common, we find recorded several accounts of its habits. Of recent authors Dr. Bugnion and Dr. Escherich dwell at some length on the habits of this interesting insect; and I am informed by Mr. Petch that he is about to publish a Paper recounting his experiences with *E. monoceros*. Of these, Dr. Bugnion's observations relate more to laboratory experiments. With regard to Dr. Escherich's account, I have not found it corroborated, in certain particulars, by my own observations. I will therefore give a short sketch of what I have been able to observe on the habits of this species.

As I have said, *Eut. monoceros* is rather common, so that I frequently had opportunities of watching them on their expeditions and when foraging. I have also opened four of their nests. (In one of them I found two specimens of a Cetoniid beetle—*Clinteria imperialis*, Payscull—the identification of which I owe to Mr. E. E. Green. Each was found in a separate cocoon, in which they lay motionless in a state of "diapause." This occurrence of *Clint. imperialis* in a termite's nest has not, to my knowledge, been previously recorded.)

Before proceeding I must mention that, in one instance, I have seen a nest built, not as usual above ground in the hollow of a tree, but underground in the chimney of a mound of *Termes obscuriceps*, surrounding the base of a tree. This proved to be not a by-nest, as is sometimes found to be the case, but a regular main nest, containing a full-sized queen, together with eggs and young larvæ. It appears, therefore, that *E. monoceros* does not construct its nests in hollow trees alone, but wherever it may find a cavity suited to its purpose.

Dr. Bugnion, for instance, records a nest built in a corner under the roof of his laboratory, and Mr. Petch has observed the building of another nest under a glass bell-jar covering a decayed stump of wood in the verandah of his office.

Foraging is not undertaken every night. There are intervals of inactivity, though sometimes expeditions may be sent out for several consecutive nights. The inmates of one nest, that used to cross the road leading to the laboratories at Peradeniya, were not to be seen for about a week, when they re-appeared. On this occasion I could see how they made their way to the tree upon which they used to feed. The old track had been obliterated by road sweepers and heavy rain when I observed the termites starting for their old feeding grounds one afternoon at 6 o'clock. The front party went forward rather uncertainly, advancing very slowly and evidently reconnoitering. Some of them went a long way down the road, which led them far from the tree; but by the following morning they had found the short cut from one tree to the other, by more or less the same path they had used before.

The exit of the foraging party from the nest begins usually between 5 and 6 P.M., and in the morning one can see a large trail returning to the nest, most of the workers carrying in their mandibles a morsel several times larger than their own heads, while others are still at work foraging. I have watched them through a Zeiss binocular microscope and could plainly see how they detached the lichens from the bark. I have also seen them gathering algæ from bricks on the road. I have never observed one of the gatherers pass over its harvest to another individual which carried it to the nest, as stated by Escherich; nor have I seen a soldier fed by a worker. Once I saw two workers, neither of which had any morsel in its mandibles, touching each other with their mouth-parts. Another time the same procedure was gone through by a worker and a soldier, but apparently no feeding was done. Anyhow, these two cases out of thousands cannot be the rule, and I do not think that any feeding takes place during foraging. But I have observed, on several occasions, the following scene. A worker with a large bundle in its mouth was standing amidst the crowd when several other workers came up to it and tore

off pieces of its morsel and went away with their booty, without any signs of protestation on the part of the robbed one. I was not able to discover the meaning of this action, but I do not think that it can be called feeding. Moreover, there was plenty of food around, and every worker could have fed plentifully without robbing his fellow. Nor can this be regarded as a division of labour, as suggested by Escherich, viz., the parts of gatherer and carrier, for only very small pieces were removed by the intruders, the rest being transported to the nest by the gatherer itself.

I have never seen workers deserting and encouraging others to do so by those rapid and abrupt movements which Dr. Escherich calls " zitterstosse." The latter, of course, I have seen many times, but I could never discover their meaning. Dr. Escherich and others believe them to be some kind of signal, warning or otherwise, but what then can be the explanation of the fact that these " zitterstosse " are executed so often when there is no one near to receive the message ? There can be no doubt about it, that the delicate sensitive organs of the termites would acquaint them with the fact that no other termite was within reach. Or is this to be regarded merely as a reflex movement induced by some unknown cause ? But then it could not be a signal, or it would naturally produce some effect upon the other individuals, and would run along the line, or it would affect at least the individual to which the signal was conveyed All I could see was that the latter sometimes replied in the same way, and then went along without altering its course; but still more often it paid no attention to this supposed signal, pursuing its course and trying to get out of the way of the " signaller."

Dr. Escherich further states that workers of *monoceros* are in the habit of dismembering and devouring their dead comrades. I have repeated his experiment by killing some of them, with the following result. When a termite happened to discover its dead comrade, it went back to return with several others. They surrounded the corpse and soon afterwards went away.

But this was not always the case. Sometimes, when one came upon a corpse, it simply went out of its way, never to return, and it even seemed to me—in one or two cases—that this place was afterwards avoided by the marching column, but this might be a mere coincidence. Once I saw the dead body lifted and carried off by a worker, just as others carry their morsels of lichen. Another time a few workers tried to lift up their dead comrade, but as it had stuck to the bark they were unable to move, and soon left it. But I have never seen a dead termite torn up, limb by limb, and devoured. The return of the foraging parties is not always finished in the early morning. I have seen them marching homewards until after 12.30 P.M.

Once my coolies brought me a nest of *monoceros* in a hollow tree stem, which they opened and searched for the queen, without finding her. Some two hours later I observed that the queen had emerged from beneath the *débris* of the nest and had hidden herself under a box. When this was lifted she began to move, and crawled up the vertical post of the house for a foot or so. In this she was supported, as it seemed, by the workers who surrounded her, especially at the posterior extremity, as if they were pushing her up. She could move horizontally, at a comparatively rapid pace, without any assistance.

Galleries on Roads.

Though galleries ramifying like roots in different directions from a central point are frequently seen on the surface of roads and have been figured both by Doflein and Escherich, there is no record of the species of termites that construct these galleries, or what purpose they serve. Strangely enough, Escherich says that he has never been able to find any termites in these galleries. During a few days' observation I found in no less than fifteen cases workers (and occasionally soldiers) of *T. obscuriceps*, and on two other occasions of *T. redemanni*.

As a rule, only a few individuals were to be found in the galleries during the morning, and they were almost deserted

after noon. But after about 5 P.M. and towards sunset the termites seemed to gather in the galleries, which I have then found to be crowded with both workers and soldiers. When the galleries were broken up some of the insects wandered about aimlessly, but most of them tried to escape into the openings leading underground.*

As to the purpose of these galleries, Escherich suggests that they originate by the rummaging of the termites in search of fungi or their spores—an opinion that is shared by Mr. E. E. Green, and which seems credible enough. Perhaps the galleries are constructed also during the search for decaying wood or stumps of trees, where these species are always found feeding. With regard to the brittleness of the galleries, I find that they are not always constructed so ephemerally as Escherich states, especially when dead branches have come in the way of the termites. Such branches are then usually covered with a strong crust of earthy matter and eaten up from the inside.

I have not touched the systematic part of my results, in this Paper, except in the case of *Eutermes oculatus*; but I hope, on my return from my present trip, to work out my further results. This, naturally, can only be done in a laboratory, with all the necessary apparatus, collections, and literature.

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* When writing the above I had not seen a paper of Dr. V. Buttel Reepens (Entomol. Mitteilungen I., I. IV., 1912, N. 4, p. 103), wherein he states that he has found both species—*T. obscuriceps* and *T. redemanni*—in the galleries.—OSCAR JOHN.

THE STONE IMPLEMENTS OF CEYLON.*

By C. HARTLEY, M.A. (Cantab.).

THE study of prehistoric implements in Ceylon is of recent date compared with that in most European countries, but still is older than many people suppose. The earliest inquiry into the subject was due, as far as I am aware, to Messrs. J. Pole of Maskeliya and E. E. Green, who has so recently left the Island. Mr. Pole especially, with more abundant opportunities for collection than Mr. Green, and perhaps possessing greater interest in the subject, has for some twenty-five years, and in spite of much incredulity and discouragement, continued steadily accumulating specimens, mostly from his own district, but partly also from more distant quarters. He now owns a very large and representative collection, including several of the most interesting stones which I have seen in this country.†

On more than one occasion Mr. Pole sent specimens from Ceylon to be examined by experts in India and, I believe, in London; but in each case with negative results. It was only in 1907 that his contentions were completely verified by the discoveries of two distinguished Swiss archæologists, Dr. Paul and Dr. Fritz Sarasin, who visited the Island in that year, and in the limited time at their disposal established once and for all the existence of abundant traces of a Stone Age. A full account of their researches is contained in the volume which they published in 1908, " Die Steinzeit auf Ceylon," describing the excavation of caves and the search for surface specimens on the hills of Uva. Many of the best specimens figured in their book are taken from the collection of Mr. Pole.

* Read before the Ceylon Natural History Society, May 30, 1913.

† News of Mr. Pole's death in England reached Ceylon in July of this year.

A few references to the Stone Age are to be found in Mr. Parker's "Ancient Ceylon" and in Dr. Seligmann's "The Veddas"; while Mr. Pole has a volume in the press which is shortly to appear. But the book by the Doctors Sarasin is so far the most complete, and in fact the only serious attempt to deal with the subject.

After a careful study of the work, although I may differ on individual points from the authors, I am filled with admiration for the thoroughness of their methods, the breadth of their views, and the ingenuity with which they apply their knowledge of modern savage races to the conditions of prehistoric life. As regards one very important particular I will refer to their book later.

To come now to my subject. Everyone is aware that the Stone Age has been roughly but conveniently separated into two main divisions, the Palæolithic or Old Stone Age and the Neolithic or New Stone Age. There are others, with which we are not at present concerned in Ceylon. A few years ago it was universally believed that the Neolithic Age extended at most some 20,000 years and the Palæolithic Age perhaps 80,000 years into the past. It is now thought by some eminent authorities that we should multiply the former by five and the latter by ten, and even so leave room for an Eolithic and a Sub-Crag Age reaching back possibly to the million. Implements of the Palæolithic Age are generally to be distinguished from those of the Neolithic Age not only in design, but also by their massiveness, their rudeness, and by the complete absence of grinding and polishing. In the case of flint, which unfortunately is not found in Ceylon, but which constitutes by far the greatest bulk of stone implements in the world, they are also distinguished by the greater wear of their surfaces, due to age and exposure, and by "patination," or the discoloration of their exterior, due to the action of acids, or of violent alternations of heat and cold, by processes which have not yet been explained.

In Ceylon, as I said, we have no flint, and the ancient inhabitants were reduced to making use of quartz, crystal, and chert, all of which are found commonly over great part of the Island, but which were almost totally neglected in lands where flint is abundant. Chert in fact was used in parts of Europe where flint was scarce; but it is rougher in texture, and breaks with a less clean and sharp edge than flint. Quartz, though breaking with an extremely sharp edge, is brittle, and difficult to work on account of its crystalline formation. Last year I submitted specimens of Ceylon chert and crystal to a professional flint-worker of Brandon in Suffolk; and he found that chert was harder than flint, but flaked fairly well, while with crystal he could do nothing at all.

It is not therefore to be wondered at that Ceylon implements are in general ruder and less skilfully worked than similar specimens in flint. As for grinding and polishing, no specimen has yet been discovered here which shows any sign of the process. Flint, we know, was polished with sand or sandstone; quartz is one of the hardest of rocks, and could hardly be ground by anything but corundum or precious stones. Hence all implements in Ceylon must be judged solely by their size, design, and chipping; and comparing the workmanship with that of European specimens, it is plain that the immense majority which have been found so far are Neolithic, and probably of no very remote date. They comprise scrapers, round and hollow (the commonest of implements everywhere), trimmed flakes for knife-blades, sharp points for boring, hammer stones, and very rare arrow-heads, mostly of simple triangular shape, one of which found by Mr. C. T. Symons is notched, a design rare in Europe, but exceedingly common in America. One bone needle or borer was recovered by me from a cave near Balangoda. Chisels or planes are also fairly plentiful, but nothing resembling an axe has yet been found—an extraordinary omission, when one considers how obvious the design is, and how common in the rest of the world. The great majority of these implements are of quartz,

chert specimens being extremely rare by comparison; but it is a remarkable fact that considerable numbers of chert chips, cores, and fragments are found in almost all places where implements occur; and it remains a problem what they did with the quantities of chert which they undoubtedly handled.

Before proceeding further, I should say a word about the places in which these Neolithic remains are found. They are invariably on hill tops, and at all altitudes from sea-level to the Horton Plains. Of course they can only be seen where the land has been cleared, as on cultivated estates or on grassy hills which have lost their top soil by weathering, as in Uva. But I have no doubt that spade-work would bring them to light almost everywhere. I have found them close to the Naga Pokuna of Mihintale, and amid sand just dredged from the sea-bottom at Jaffna. The bright, clear chips stand out vividly against the crumbling earth of the hills, and often in such numbers as almost to hide it.

At very rare intervals one picks up among these brand-new chips stones of another type, fragments of chert worn and weathered, but still retaining indubitable traces of man's handiwork. It is not so much in size or in style of work that they vary from the usual rather shapeless fragments that one finds scattered broadcast over the patanas, but in colour and texture of the material. They are heavily patinated, which in itself is regarded as a proof of antiquity; they are generally light in colour, and their surface is spongy and porous, differing markedly from the close, compact grain of newly-fractured chert. These I believe to be rare survivals of the Palæolithic Age; but as they are found at present only on the surface, it would be rash to assume it without further proof. Before we can be sure of their identity, it will be necessary to discover them deep below the modern surface in gravel-beds, possibly in association with the remains of extinct animals. Such a find has of course never been made in Ceylon; but I do not despair of some really valuable discovery being made, if we can interest gem-seekers in the

subject, or if some one living in the neighbourhood of gem-pits devotes a little time occasionally to raking over the spoil-heaps. I have in my collection no implement which can be certified as Palæolithic, but I show one or two to-night which raise a strong presumption in their favour, and Mr. Pole has a few surface specimens from Maskeliya which remind one very strongly of relics of the Old Stone Age. I would call your attention particularly to one fragment of chert on the table, found by me lately on the surface at Bandarawela. In comparatively recent times this stone has been chipped, probably by a Neolithic savage, who required flakes for some small tool. This recent chipping is yellow and highly lustrous, which alone is a sign of a respectable antiquity. But the original mass, where untouched, is of a deep chocolate-brown, and shows marks of workmanship bolder and incalculably more ancient than the former. The ridges left by the old chipping are so worn as to have quite lost their sharpness; and I have no hesitation in saying that if found in an admittedly Palæolithic neighbourhood in Europe, this stone would be accepted without any question. Much however remains to be done in Ceylon before any certainty can be attained. Our greatest want is the exploration of gravel-beds, which seem to me surprisingly rare in our land.

Before I bring this Paper to an end, I must give a short account of my recent discovery of the rare and mysterious class of implements known as Pigmies, which brings me back once more to the valuable work of the Doctors Sarasin. On page 30 of "Die Steinzeit auf Ceylon" they write as follows:—"More seldom there occur also small knives of this fine sort, fashioned obliquely, such as are illustrated in figures 89, 96, and 104, with the edge turned downward, of which especially the first attracted our attention because the thickened, bow-shaped back is formed by carefully-applied minute chipping, a secondary work which we recognize in a very similar form on the fine blades and points of the so-called (Pigmy or) Tardénoisian implements, certainly a tedious work on so

brittle a material as crystal. In any case this obliquely fashioned knife is unique in our collection, whereas on the other hand, as is well known, the whole class of Pigmies is composed of such microliths made of flint." They thus leave the question in doubt, but the three illustrations referred to show unmistakable Pigmy specimens. In the past two years I myself picked up a few puzzling implements in Ceylon, which I finally sent to the Rev. R. A. Gatty, who is one of the chief English authorities on the subject, for his opinion. He replied at once that there was no doubt whatever as to their identity, and begged me to go on searching. By the beginning of this year I had accumulated about a dozen specimens from Diyatalawa, Pattipola, Dolosbage, Hatton, Gampola, and Nawalapitiya; which shows that they are at any rate widely distributed. They have since been discovered on the Horton Plains and at Matale. In March and April of this year I thoroughly explored the neighbourhood of Bandarawela, where I found them in enormous quantities. I have collected over 3,600, partly from the surface, partly by digging. It was only on four hills that they occurred in numbers; but one or two were to be found by careful search on other hill-tops where chips were plentifully scattered.

I cannot go deeply into the study of Pigmies to-day, but I may say briefly that they are the enigma and the mystery of the Stone Age. They have been found only in quite a few places, four or five of which are in England, a few in caves of France and Belgium, and one in India in a cave of the Vindhya Hills. Except in Ceylon they are, I believe, always made of flint. They are found in caves or on low sandy hills, always, I am told, on the western slope; and in one case, in Lancashire, they have been unearthed under ten feet of peat, implying a very considerable antiquity. Archæologists are still in doubt whether they belong to the Old or the New Stone Age; and they are almost equally in doubt as to the purpose for which they served. Where they occur they are found in thousands, and in almost identical shapes and sizes. The commonest

form in Ceylon is called the lunate or moon-shaped; but there are others, of which you will find specimens here to-day. One shape well known in India appears to be missing in Ceylon. On the other hand, some of the lunates found by me seem to be very much larger and thicker than any which I have heard of elsewhere. More than this I do not feel inclined at present to say. I intend sending specimens to Mr. Gatty and to the British Museum, and hope to have their opinions in a few months. I wish, however, to call your attention to the extreme beauty and delicacy of many of the implements, and to make one suggestion in that connection. As I said before, there is great uncertainty as to the uses to which they were put. Some think they were surgical and tattooing lancets; others that they were fish hooks; others that they were the implements of some domestic manufacture, such as weaving or wool-carding; others that they were the barbs of harpoons, spears, and arrows. It is quite possible that they were all these and more. But another very important point remains to be settled: Were the people who made these exquisite Pigmies the same people who made the clumsy scrapers and blades of Neolithic type? Our first impulse is to say that such a thing is impossible; but consideration may lead us to change our view. There are great gaps in the Neolithic armoury. After years of search I have not yet found an axe, a saw, or a spear-head, and very few arrow-heads. It is however inconceivable that savages could have dispensed with spears and arrows in large quantities; and admitting this, one is at a loss to understand why they are not found in the same numbers as in other lands. I grant that we are still only at the threshold of discovery, and I do not overlook the possibility that the implements now wanting may yet be found; but I believe that some day it will be agreed, if not proved, that the same people made both kinds of implements continuously, and that the smaller and finer Pigmies were used in numberless ways to supply the deficiencies of the coarser and ruder Neolithic tools.

REMARKS ON DR. PEARSON'S REVIEW OF THE SCIENTIFIC WORK DONE ON THE CEYLON PEARL BANKS FROM 1902 TO 1912.

By T. SOUTHWELL, A.R.C.S. (Lond.), F.Z.S., F.L.S.

Deputy Director of Fisheries, Bengal, Bihar, and Orissa; late Scientific Adviser and Inspector of Pearl Banks to the Ceylon Company of Pearl Fishers.

THE January issue of *Spolia Zeylanica* (Vol. VIII., Part XXXII.) contained a review of the scientific work on the Ceylon pearl banks from 1902 to 1912, by Dr. J. Pearson. Certain features of this review call for attention, and will be dealt with as briefly as possible in the following Paper.

Dr. Pearson states that he was prompted to write his review because of certain misunderstandings which undoubtedly exist, and with a view to determining how far the scientific investigations have progressed towards the attainment of their chief object. Unfortunately, certain features of the work appear not to have been fully comprehended by the writer of the review, and consequently the review in question, which is in reality a critique, unnecessarily complicates the whole question. The reveiw is of value, however, as setting forth the opinions of a scientist of considerable standing. It would have been of still greater value had the writer's opinions been formed after, instead of before, some practical experience on the banks had been acquired. We make no special emphasis on this point, however, but as bearing on the question it is interesting to note that with reference to the establishment of a close season for the window-pane oyster, Dr. Pearson first stated (*Spolia Zeylanica*, Vol. VII., Part XXIX.) that he agreed with Hornell that a close season for that oyster should be established from May to January, but after some practical experience on the banks in question, which have rendered it likely that these oysters spawn during January and February, Dr. Pearson is now of opinion that fishing on the *Placuna* beds should be restricted to the months of March,

April, and May. With reference to the pearl banks, there is every reason to anticipate that Dr. Pearson's experience thereon will result in some modification of his present opinions, and, whatever these opinions may ultimately be, they will then be of greater value. As far as my own work is concerned, I am prepared to let it stand as it is. It was never intended to be complete, and only future years can bring to light its value or otherwise. The severe criticisms to which my reports have been subjected have resulted in new ideas and explanations having been advanced in order to explain away the results acquired during five years. The criticisms have, however, only extended the field of possible explanations, and have left me the more convinced that the results already obtained first require to be understood before they can either be extended or supplanted. As in the present Paper I have nothing to add to my published reports, I propose replying under the headings adopted in Dr. Pearson's Paper seriatim.

Brief Résumé of Scientific Work.

Dr. Pearson remarks that the results of the work of Captain Kerkham and myself " are naturally of a somewhat meagre nature." At the same time he complains of the scarcity of information as to what took place during the earlier part of our work. Further, where we give full and careful accounts of our work, as in the case of currents, the results are not accepted by him, and it is stated that these results are not convincing, and that more work is needed on this important point. The latter part of this remark is gratuitous. We repeatedly made this statement in our own reports. Whether the information referred to is available or not, Dr. Pearson commences his investigation of the questions connected with the pearl banks with a fund of published information which no other worker has ever possessed. Under such circumstances his complaint is hardly logical. Moreover, all information available which he may require can be had for the mere asking. The period regarding which no published reports are obtainable synchronized with a period of barrenness, and the importance of information regarding this period is dwelt on by Dr. Pearson. The barren years still persist, and the opportunity is thus present for the necessary data being collected now.

Herdman's Summary and Recommendations.

A complaint is again made that published information regarding the gut contents of fishes is not available, as such information would have been of interest in comparing the fish fauna of the banks during fishery years and non-fishery years. All available information could again have been had for the asking. We showed that a bed of 400,000,000 spat had been destroyed on the Periya Paar Kariya during 1908. The opportunity is still present for determining the conditions during barren years. If all the information which Dr. Pearson appears to require had been available, there would have been but little work left for him to do on the pearl banks. With reference to transplanting, Dr. Pearson states that it has not been carried on in a proper manner. As far as I know, only one opportunity for transplanting occurred. That was during December, 1907, when spat, estimated at between nine and ten millions, was transplanted from the Periya Paar to the Cheval Paar by Capt. Cribb during Mr. Hornell's managership. If these operations had been successful, the oysters would have been fished in due course. Dr. Pearson states that no subsequent report indicates whether the experiment was a success or a failure. He is in error in stating that I transplanted 9,000,000 spat. No spat was ever transplanted by me, nor did I anywhere state that I had done so. After Hornell's retirement I made an attempt to discover the reason why the transplanting operations had failed. My remarks will be found in the *Ceylon Marine Biological Reports*, and these remarks refer to the oysters transplanted by Hornell.

The only deposit of spat which occurred during my period of office was that found on the Periya Paar Kariya, and this deposit was annihilated by voracious fish, an account of which will be found in Part IV., *Ceylon Marine Biological Reports*. It is idle for Dr. Pearson to remark that subsequent to Herdman's reports there is little evidence to show that efforts were made to seriously guard against the alleged evils of overfishing and overcrowding. A serious attempt was made to transplant on the only occasion which presented, when, as we have seen, between nine and ten millions spat were transplanted. The operations occupied six weeks and cost probably well over

£1,000. With regard to overfishing there is not the slightest doubt that this took place during the Company's régime, as indeed it has done at every fishery, but if Dr. Pearson's interpretation of our current work is correct, this could not have mattered, since any spat liberated by oysters which might have been left for breeding purposes would have been carried away, a conclusion with which I entirely disagree.

Pearl Production.

I made the first attempt to ascertain the exact nature of the parasites contained in the globular cysts found scattered about in the tissues of the oyster, by the only method possible, viz., by feeding experiments. Various fish were fed on oysters containing the cysts. The fish were first treated with castor oil and male fern extract in order to get rid, if possible, of any parasites already present in their intestines. A test examination of a dosed ray indicated that the purgative had been fairly effective. After the other fish had been feeding on oysters for several weeks, they were killed and carefully examined. Large numbers of *Tetrarhynchus unionifactor* (the pearl-inducing worm) were found. Other cestodes were also found, viz., *Tetrarhynchus herdmani*, *Phyllobothroides hutsoni*, and *Phyllobothroides kerkhami*. In my reports (*Ceylon Marine Biological Reports*, Parts IV. and V.) I pointed out that the experiment was not absolutely conclusive, but that there was every reason to believe that *T. unionifactor* was the adult of the pearl-inducing worm, and that other species found as a result of the feeding experiments were parasites already present in the intestines of the fish when the experiment was begun, and which the purgative had failed to dislodge. The strength of the evidence lay in the fact that *T. unionifactor* was obtained on *both* occasions, and that in *all* other rays examined from the open sea, and which had not been fed on oysters, no specimens of this species had been obtained, although *Tetrarhynchus herdmani*, *Phyllobothroides hutsoni*, and *Phyllobothroides kerkhami* were common. The circumstantial evidence is as strong as it could well be. *Every* feeding experiment is always open to the objection that unless the animal to be fed on larval cestodes is actually killed and examined, any critic can say that the adult parasite was already

present when the operations began. Dr. Pearson states that it would appear that all the species of cestodes, obtained as a result of the feeding experiment, were derived from the oyster. In that case he admits the entire efficacy of the purgative. Commenting on my statement that I believed it probable that these cestodes (*i.e.*, those other than the pearl-inducing worm) were present when the fish were placed in the nursery, and that the purgative employed failed to dislodge them, Dr. Pearson states that if that was the case the value of the experiment is entirely annulled. According to him, therefore, the experiments are useless, and they also prove that four species of larval cestodes inhabit the tissues of the oyster!

To advance the theory that all the adult cestodes obtained from the fish were derived from the oyster, is to brush aside the obvious explanation, backed by all available evidence, and to substitute a less probable theory whose only support is its ingenuity. If the larva of all these four species of cestodes occur in the oyster, why was it that during one year only *T. herdmani* was obtained, whilst the next year *P. hutsoni* and *P. kerkhami* were obtained, *T. unionifactor* being present in both cases?

Currents.

We stated that during our period of office we found no evidence to support the conclusion that oysters were occasionally silted over by sand. We gave this as being our actual experience during the five years we held office. Dr. Pearson states that our conclusions can hardly be regarded as convincing. The mere expression of an opinion cannot alter the actual experience we had. The extract from Captain Legge's report, which Dr. Pearson quotes as being opposed to our results, is of no consequence. According to this report, places on which Captain Legge dived during March of a certain year were then level rock with a coating of three inches of sand. During November these spots were covered with a foot of sand. There is not the faintest possibility of the spots on which Captain Legge dived in March being exactly the same as those dived on in November. Again, it is stated that, as the tanks submerged by Captain Donnan (covering perhaps eight square yards of the ocean floor) on the Shoal Buoy

position could not be found during a certain November, they had therefore been silted over. Enormously larger areas than that occupied by these tanks have repeatedly been missed. Exceedingly skilful navigation combined with a large percentage of luck is required in order to locate an area eight yards square situated ten miles out at sea. The obvious explanation is that the tanks were missed, and there is not the slightest proof or probability that the tanks were actually silted over.

The acceptance of this evidence by Dr. Pearson is curiously at variance with the critical attitude adopted by him in the rest of his Paper. During the six successive November inspections which I attended, these tanks were found on every occasion except one. In the latter case the weather was so bad that inspection work was impossible, and consequently the search for the tanks could not be carried out thoroughly. The time occupied in locating these tanks has varied in my experience from three hours to two weeks. But when located they were never found to be covered with sand, even though the maximum silting effects of the south-west monsoon would then be apparent. The counter-effects of the north-east monsoon referred to by Captain Legge could at that time of the year have produced no change, as that monsoon had hardly commenced.

We stated in our report that large "pot-holes" occur on certain parts of the pearl banks. If sand drifts about, why are these pot-holes never filled up ? We never assumed that the danger to oysters, caused by a bottom current, lies merely in the fact that oysters will be swept away. The danger of drifting sand was very fully recognized ; but any movement of the bottom water which would produce silting sufficient to cover and destroy a bed of oysters, say a half-mile square, must be very great, and our experience showed conclusively that during the period of our observations no such silting has taken place. Our results were entirely negative, and we could have wished them otherwise, for then the solution of certain obscure problems would have been obvious enough.

Drift Bottle Experiment.

Dr. Pearson has, unfortunately, failed to understand the results we obtained, and consequently his remarks on this

subject are difficult to co-ordinate. Drift bottle experiments were first commenced by Hornell on Herdman's recommendation. These bottles were all liberated in unsuitable localities, and frequently during transitory stages of the monsoon. The results were therefore of little or no value. The fullest details of all these drift bottle operations are contained in a ledger handed over to the Ceylon Government by the Ceylon Company of Pearl Fishers during 1912. This ledger should be accessible to Dr. Pearson. We found that during the south-west monsoon there was an oceanic current running from west to east in the vicinity of Ceylon. An account of the origin of this current will be found in the "Challenger" publication—*The Science of the Sea*—and a chart is given on pages 60 and 61. When we published our results we were unaware that this current had ever been noticed before. During weak south-west monsoons this current does not touch Ceylon, but runs to the south and west. Under these conditions there is a surface drift on the banks caused entirely by the wind, and this drift runs to the north, both on the Ceylon and Indian sides. This explains the difficulty quoted by Dr. Pearson on page 216, paragraph (*b*), although he himself explains his own difficulty on the same page. The same explanation was given in our report (Part VI., page 236).

Dr. Pearson states that (i.) we have not fully discussed the causes which produced these currents ; (ii.) that we have not realized that the drift experiments do not assist us to discriminate between oceanic current and ordinary surface drift; and (iii.) that in a weak south-west monsoon the northerly current flowing along the Ceylon and Indian sides of the Gulf of Mannar is probably only a surface drift.

With reference to (i.), our Paper showed that we had to deal with the inter-action of two phenomena : (*a*) an oceanic current and (*b*) a surface drift, caused entirely by the wind. A discussion of (*b*) was given by us in detail. At the time we wrote the origin of the oceanic current was unknown to us. That, however, in no way affected the results. It is not necessary to know the origin of wind before ascertaining that it blows, and that it blows in a certain direction. But, as before stated, the origin of this oceanic current is dealt with in other publications. In

large measure it is produced by the spin of the earth on its axis.

With reference to (ii.), it would be strange if, after five and a half years of intermittent work out at sea, ably assisted by a Lieutenant in the Royal Naval Reserve, we both failed to realize the difference between an oceanic current and a surface drift. It is true that at any given time, and at any given place, it is well-nigh impossible to state whether an obvious surface movement is due to an oceanic current, or whether it is merely surface drift caused by the wind. Circumstantial evidence would afford very valuable clues. In the time at our disposal it was utterly impossible to attempt the differentiation by means of water analyses. We shall wait with interest to see what progress is achieved in this line during the next ten years.

With reference to (iii.), we have already pointed out in this Paper, and in our Report (Part VI., page 235), that during a weak south-west monsoon no currents are present on the plateau which was under lease, and that the northerly set is entirely a surface drift produced by the prevailing wind.

Bearing of Drift Bottle Experiment.

Dr. Pearson's statement on page 218, that we have failed to realize that during the north-east monsoon spat may be carried from the Ceylon banks to the Tuticorin banks, is dependent on the supposition that oysters spawn in December to February.

With reference to the spatting maximum, which is supposed to take place during the north-east monsoon, Dr. Pearson's conclusions are based on a short statement to this effect made by Hornell. The phenomenon has never been noticed by any other worker in the whole history of the pearl banks. As the results obtained by Hornell are so often stated by Dr. Pearson to be in error, it is curious that this remark of Hornell's should have been given such undue prominence. As it has yet to be established that there are two spawning maxima, there is little point in discussing improbabilities. If two spawning maxima really exist, this mollusc will differ remarkably from *Placuna* and from most other molluscs, both in Indian and home waters, whose habits are known. Over 300 samples of plankton, collected over four years, during the

months of November, December, January, and February, from the Challai, Alanturai, Dutch Moderagam, and Karativu Paars, have been carefully examined by Captain Sewell, B.A., I.M.S., Surgeon Naturalist to the Marine Survey of India and Professor of Biology in the Medical College, Calcutta. The pearl banks have not been entirely barren during the whole of the time over which the collections were made. Yet no trace of oyster larvæ has been found in these plankton collections. A few such larvæ have been noted in two plankton catches from Marichchukkaddi Bay. Such larvæ have undoubtedly come from the inshore bed of oysters on the Kondatchi Paar. The oysters on this and other inshore beds spawn irregularly (*Ceylon Marine Biological Reports*, Part V., page 202). The Kondatchi Paar lies about eight miles north of Marichchukaddi Bay, and as the wind was north during the time when the plankton was collected (north-east monsoon) the occurrence of a few oyster larvæ in the catches from Marichchukkaddi Bay is readily understood. It is possible that such a circumstance may account for the phenomenon observed by Hornell.

Dr. Pearson is only partly correct in stating that we established the presence of a current during the north-east monsoon, which, sweeping the Ceylon banks, was capable of carrying pearl oyster larvæ from the Ceylon to the Indian side. We stated that during the north-east monsoon an oceanic current ran up the west coast of Ceylon as far as Tallaivillu Point, and from thence took a westerly course. North of this point the surface currents (drifts) vary even during the day with the direction of the wind by which they are controlled, and to which they entirely owe their existence (*Ceylon Marine Biological Reports*, Part VI., page 232).

It frequently happens that bottles liberated on the pearl banks during the north-east monsoon are blown south and become involved in the current running west. Our results showed that 16·76 per cent. of bottles liberated on the pearl banks during this monsoon were recovered from Southern India. In other words, 83·24 per cent. of bottles were lost. Spat, if present, would take a similar course. The great bulk of it would be *lost*. It will be noted, however, that even if spat is liberated during the north-east monsoon the chances

of its reaching the Tuticorin banks are remote, especially since the route which such spat would have to take is a very long one. In all probability they would develop a shell, and sink long before they reached the Tuticorin beds.

Remarks.

The inspections of 1908, 1909, 1910, and part of that conducted during 1911 represent the operations over which I had charge. During the whole of this period the banks were barren. The rôle of critic is proverbially an easy one. It is not unlikely that many of the problems connected with the pearl banks (which ought to have been settled long ago) will still await solution a couple of decades hence.

Dr. Pearson clearly recognizes the nature of the work ahead. It is repeatedly stated that certain problems we—and others—have attempted to elucidate will require re-investigation. There are few scientific problems to which this remark does not apply. Our continued interest in the Ceylon pearl fisheries leads us to hope that the progress during the next four years will be greater than we found it possible to achieve in the same period. If we have succeeded in furthering the elucidation of the problems involved, in removing some from the realm of mere speculation, and in initiating lines of work and research, the development and expansion of which will at some future time result in a solution of some of the present difficulties, our work will not have been wholly in vain.

In conclusion, I would call attention to the following extraordinary statement on page 198 of the last issue of *Spolia*, where, in Captain Legge's Paper, it is stated that: "True pearls ...... are found in the intestines of the oyster, and, when they reach such a size as to cause great discomfort to the oyster, the oyster either dies, or, as I have observed, forces the pearl towards the opening between its valves."

Another surprising statement is found in the same article on page 204 of the same issue, where we are informed that "it is not true, as has been stated, that our blank years are due to over-fishing." Finally, the quotation ascribed to Captain Kerkham on the same page of the same issue is from my own pen, and will be found on page iv. of Part VI., *Ceylon Marine Biological Reports.*

WINDOW-PANE OYSTER INVESTIGATIONS, JANUARY AND MAY, 1913.

By G. M. Henry.

(With two Plates.)

IN January last I went to Lake Tamblegam, primarily to obtain the larval stages of Placuna placenta, which is supposed to spawn in the latter part of December or in January. In addition to this I had arranged to make a survey of the whole lake, to see how the large beds of one-year old oysters which were discovered by Dr. Pearson in May, 1912, were thriving, and to take a series of measurements which would throw further light on the growth-rate. When I arrived at Tamblegam I found that the district was in a state of flood owing to the abnormally heavy rains. On January 12 a sample of plankton was taken by means of a tow-net over the principal part of the bed from Kodaipota to Sallaimunai, but the catch consisted entirely of freshwater organisms and contained no Placuna larvæ. The water tasted quite fresh, and was full of light-brown sediment brought down by the flooded rivers. Under such conditions it was useless to expect to find larvæ, and in consequence attention was subsequently directed to inspecting the existing beds. A preliminary line of nine dives was taken from Kodaipota to Sallaimunai, and the oysters were found to be in a moribund state. Few were actually dead, but nearly all were dying, their valves tightly closed, mantle and foot fully extended. Very little contraction could be induced by touching the mantle or other sensitive parts. When actually dead the valves gape and the pale appearance of all the organs clearly indicates death.

The three following days were spent in inspecting and tow-netting with the same result—oysters rapidly dying everywhere, except in the portion of the lake between Pataiaddimunai and Korrinjavat, where only a few were dead;

the majority being quite normal and healthy-looking. As was to be expected, no Placuna larvæ were discovered in the plankton. The gonads of most of the oysters were large and swollen, but of a sickly grayish-yellow colour instead of the rich orange of the normal ripe gonad. A microscope examination failed to reveal either ova or spermatozoa, although numerous gonads were examined.

On the 16th, 17th, 18th, and 19th inspection work was rendered impossible owing to the continuously heavy rain. On the 20th Nachchikuda Bay was inspected. There is a small bed of oysters at the head of this bay which do not grow so rapidly as those in other parts of the lake, but they appear to be much hardier. None of these oysters were dead.

On the 21st the south-west corner of the lake was inspected. All the oysters were dead and putrefying, and occasionally one saw the bodies of oysters floating on the surface in a high state of decomposition.

On the 22nd the inspection was completed by a line of dives taken from 600 yards south of Periya Kalmunai to the mouth of the Polokarai-ar; but no oysters were found except at the last station, where the oysters were abundant but all dead.

Whenever possible, tow-nettings were taken throughout the inspection, but no Placuna larvæ were discovered. The usual planktonic organisms were not present, and mosquito larvæ and small water beetles formed the only captures.

A further inspection was commenced on May 19. The Government canoe was kindly placed at my disposal by Mr. T. A. Hodson, the Assistant Government Agent at Trincomalee, and I was assisted by a peon using one of the local boats. Dives were made at 110 stations. In his Report on the Window-Pane Oyster Investigations, 1912, Dr. Pearson divided the oyster-bearing portions of the lake into twenty-two areas, which are lettered from A to W, and I have retained these areas in the present report. A description of the conditions regarding the oysters in each area in May, 1913, follows.

Wherever possible, ten oysters were measured at each station.

Area A.—Second-year oysters were found in the northern extremity of Nachchikuda Bay. They averaged 4·627 ×

4·983 inches. A single young oyster measuring 1·125 × 1·25 inch was taken about 200 yards south of the nursery.

Area B.—The oysters in this area are confined to the southern part near Kodaipota. They are all young, and average 1·912 × 2·125 inches.

Area C.—Oysters are scarce in this area and are only found in the south-west half, the remainder apparently being unsuitable for Placuna. The average size was 1·784 × 2·095 inches, against an average of 1·59 × 1·69 inch in May, 1912.

Area D.—Young oysters were found at only one station in this area, at its southern corner. They averaged 1·787 × 2·25 inches.

Area E.—This area contains part of the only remnant of the large bed of oysters which was present last year and which was decimated by the rains in January. These oysters and those in the north end of Nachchikuda are the only survivors. There are apparently no young oysters mixed with these second-year oysters, and I have noticed that new broods of oysters do not seem to settle among one- or two-year-olds, to any great extent, although the limits of their respective beds may overlap a little. The average size of the second-year oysters in the area is 5·202 × 5·482 inches, and they were abundant.

Area F.—Last year's oysters were found at two stations in this area also, at one of which, 200 yards south-east of the estuary of the Manal-ar, they were very abundant. Their average size for the area was 5·231 × 5·537 inches. At another station young oysters were found with an average size of 1·555 × 1·65 inch, but they were scarce.

Area G.—Second-year oysters were found abundantly at two stations in this area, and young oysters averaging 1·949 × 2·2 inches at two other stations. In May, 1912, the oysters in this area averaged 2·16 × 2·32 inches, and were probably of the same age as the present young ones.

Area H.—This area is almost entirely covered with young oysters averaging 1·936 × 2·209 inches. They are, however,

not very abundant. The average size of oysters in this area in May, 1912, was 2·20 × 2·39 inches.

Area J.—Oysters were found at only one station in this area, just opposite the mouth of the Sembian-ar. They were not very abundant and averaged 1·55 × 1·7 inch. This area last year was one of the most prolific, the oysters being almost piled on top of one another and averaging 1·96 × 2·15 inches.

Area K has three oyster-bearing stations, at which oysters were fairly abundant, especially in the northern half of the area. They averaged 1·816 × 1·987 inch, as against 2·57 × 2·79 inches last May.

Area L.—This area is well stocked with oysters having an average size of 1·304 × 1·45 inch, which does not compare very favourably with the average for May, 1912, of 2·14 × 2·28 inches. They are not so abundant as last year.

Area M.—Young oysters were found close to the shore along the entire boundary of the area, despite the fact that the water in this part is very shallow and covers a sandbank (Muttikallam). At one station 300 yards south-east of Sallaimunai mark they were abundant. The average size for the area was 1·664 × 1·774 inch, as against 2·55 × 2·85 inches in May, 1912. Probably most of the oysters will die off shortly, owing to the undoubtedly unsuitable conditions.

Area O.—This area has young oysters in abundance almost all over its surface. Their average size is 1·814 × 2·032 inches.

Area P.—Oysters abundant in the southern half, but practically absent from the northern half of this area. They compare unfavourably in size with the oysters in this area in May, 1912, averaging only 1·591 × 1·737, against 2·46 × 2·27 inches last year.

Area Q.—Oysters were taken at only one station in this area, their average size being 1·383 × 1·516 inch. They were fairly abundant.

Area R.—This area is covered with oysters with the exception of the south corner, where the Sinna Palamput-ar opens

into the lake. The oysters average 1·778 × 1·946 inch, against 2·04 × 2·16 inches in May, 1912. They are very abundant on the whole.

Area S is completely covered with oysters of very good average size, and very abundant. They average 2·094 × 2·354 inches. In May, 1912, only one specimen measuring 2·87 × 3·25 inches was taken in this area.

Area T is another well-stocked and satisfactory area, the oysters being both abundant and of good average size. They average 2·012 × 2·274 inches.

Area U.—Oysters abundant in the south-east portion of the area, but scanty further north. They average 2·08 × 2·391 inches.

Area V.—Oysters abundant and having an average size of 1·87 × 2·162 inches.

Area W.—These three last areas were quite barren of oysters last year and the year before, and this lack of oysters was put down to the extreme softness and thickness of the mud which forms the bottom of these areas, but apparently this is no preventative of oysters in their young stages at least. The average size for this area was 1·766 × 2·075 inches.

It will be seen that the deposit of oysters this year, while more extensive and evenly distributed than last year or the year before, consists of smaller oysters on the whole. Also one does not find the densely packed patches which were evident last year. One would naturally expect as a result of this better distribution, a corresponding increase of size compared with last year's oysters, but this is not so. It is possible that the present bed of oysters was spawned later in the year than the 1912 bed, and this seems the most probable explanation, because the rains (which almost certainly prevent spawning while they last) continued much later this year than they did in 1912.

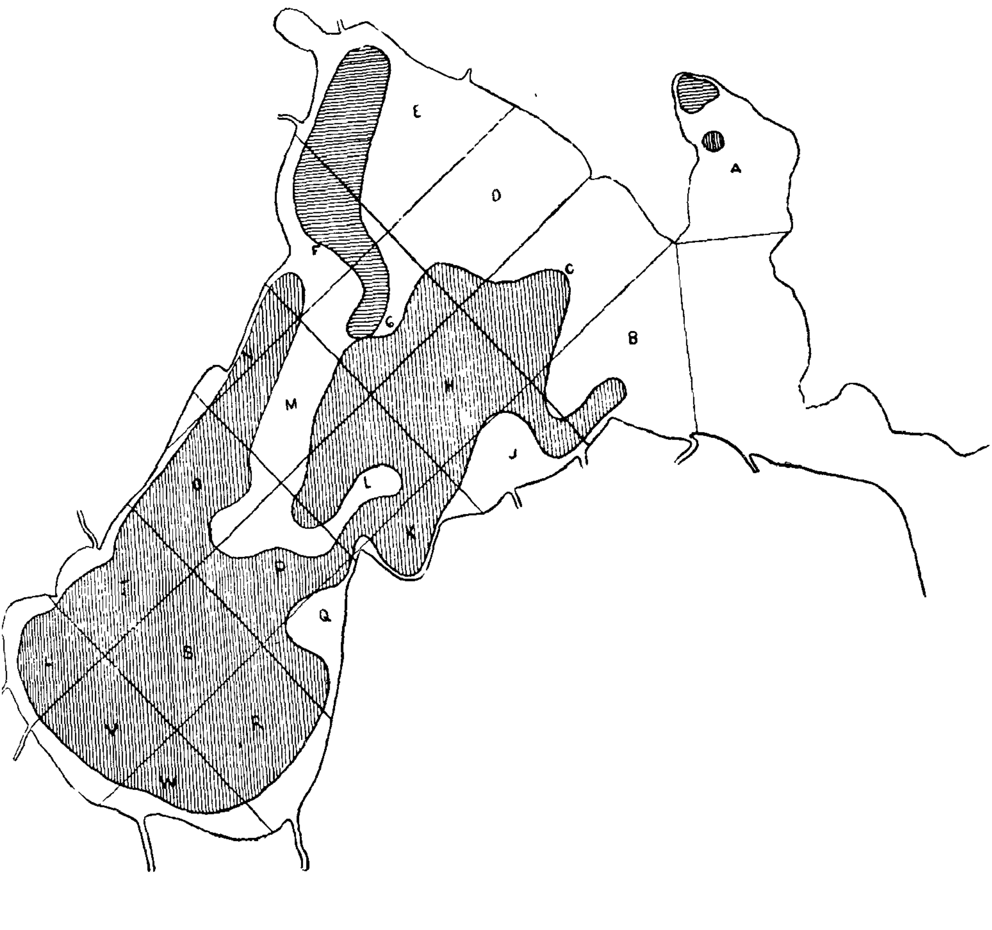
In addition to the work of inspecting, a series of water-samples was taken in various parts of the lake for the purpose of determining the salinity and its bearing on the questions of distribution and growth-rate, but the samples have not yet been tested.

A sketch map is annexed showing the distributions of 1912 oysters by horizontal lines, and that of this year's oysters by vertical lines. It also indicates the areas mentioned in this Paper. A diagram is also given which compares the sizes of first-year oysters in May, 1912, with first-year oysters in May, 1913, the measurements of the short diameter being given.

Note by J. Pearson.

Mr. Henry's report of January and May inspections shows once more how critical is the rainy season of the north-east monsoon. In January, 1912, a fairly large bed of oysters was practically wiped out as the result of the heavy rains in the previous November and December. In the inspection of May, 1912, a very large bed of young oysters was discovered. These have also been destroyed by the excessive rains of January, 1913. As a rule January is a dry month. The oysters had evidently survived the November and December rains, and it is unfortunate that the rains in January were so abnormally heavy. It may be presumed that oysters which survive the first rainy season are not so much affected by the second, and if the large bed of oysters could only have survived, a lucrative fishery would have resulted in two or three years' time.

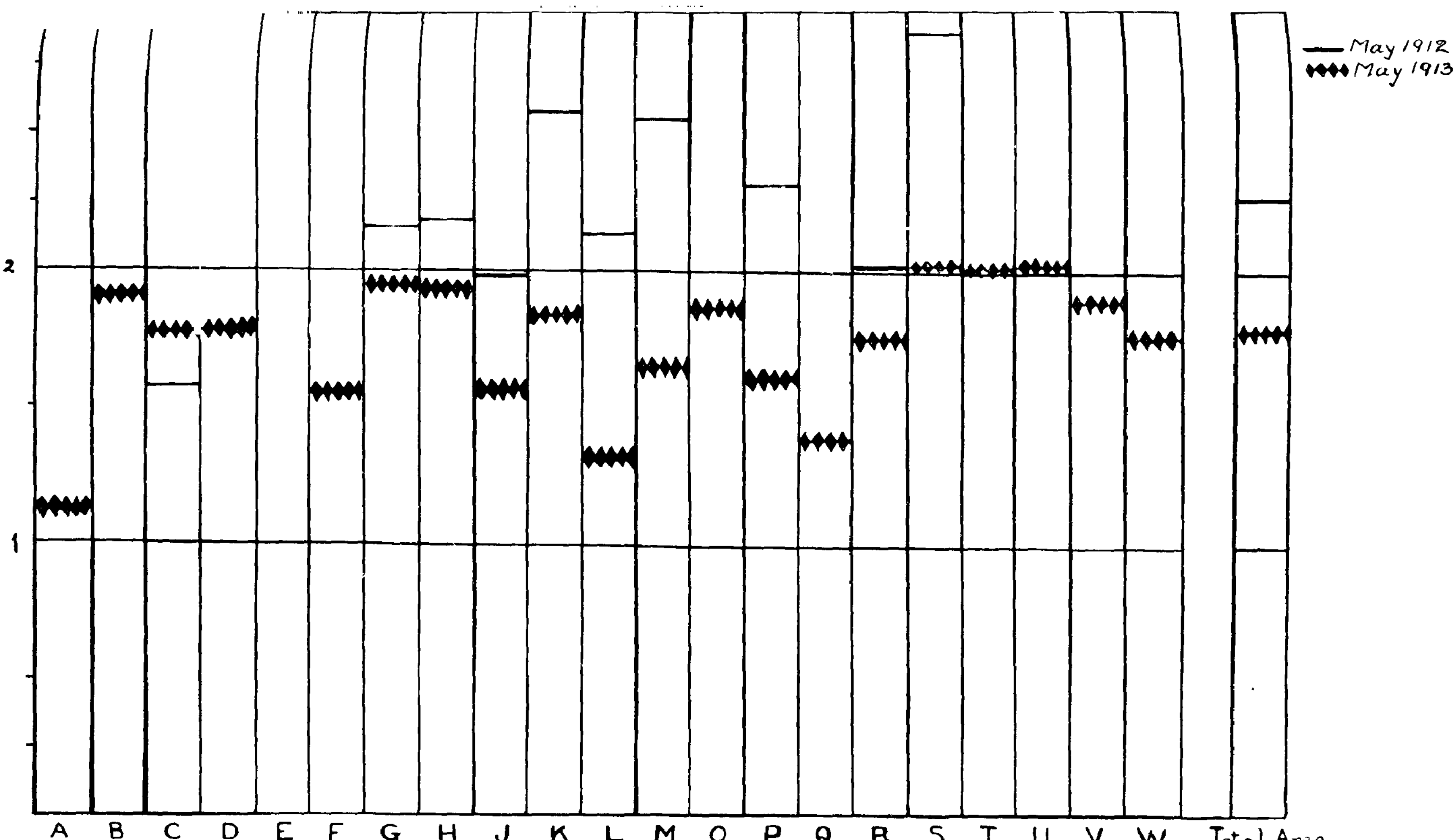
It seems highly probable that Placuna spawns when only twelve months old, and the evidence collected during the last two years renders this almost certain. Although we have not yet been able to discover the larvæ in the plankton, we can be certain that spawning does not take place until after the rains. If the larvæ were liberated before or during the rains they would be killed. For the last two years we have had large spat-falls after exceptionally wet seasons. We are thus forced to the conclusion that spawning follows the rains. In fact it is probable that the low salinity of the water stimulates the reproductive organs. Mr. Henry shows that the young oysters found this year are smaller than those recorded last year. This is probably due to the fact that the rains were



Distribution of Oysters, May, 1913.

Horizontal lines, Second-year Oysters; Vertical lines, First-year Oysters.

(Scale, $1\frac{1}{6}$ inch to a mile.)



Comparison of First-year Oysters. May, 1912, and May, 1913. (Short diameter ...)

Mr. Parker finds in accounting for pointed holes, quite apart from the fact that the surface of the rock on which these particular holes are cut, while being tolerably flat, is scarcely smooth enough for pebbles, to have been "played" from hole to hole. Moreover, there is the fact facing us that this same stone had pieces wedged out of it for building purposes, and the wedge marks are still to be seen side by side with the cup marks.

In one of Mr. Parker's sketches, in his work "Ancient Ceylon," the slope of a rock having these cup marks appears to be of so high an angle as to negative still further the theory that they were constructed for some game.

I venture to submit these remarks with a view to directing further investigation, as it still is by no means clear what these cup holes were for.

[*Note by Mr. Parker.*—I am afraid that your explanation of them will not account for them. Have you ever tried to get up the heat required for smelting iron in one of the holes? I feel sure that it would be impossible. Also the heat that would melt ironstone would also melt the other stone in which the holes are cut. In the *insides* of the holes I examined I found no sign of the use of heat in them. Most of them were well polished, or at any rate, well smoothed over. Any explanation ought also to account for the *pointed* holes. I believe the holes were first *cut* with chisels, and then completed and perfected by turning something round in them for a long time—but whether this was before their employment for the purpose for which they were made, or in consequence of their employment, I do not know. I fancy it was owing to their long use, however, that they became worn so smooth inside, and of such perfect shape.—*W. H. Parker.*]

FREDERICK LEWIS.

Colombo, April, 1913.

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8. *A Predatory Red Ant.*—Last May I noticed a large butterfly fluttering vigorously on the ground evidently in the grip of something, so I ran out to see what it was. A single red ant (*Œcophyllia smaragdina*) had seized it by one of its antennæ, and was holding on grimly, despite the butterfly's frantic struggles, which must have been almost sufficient to drag the ant's body and legs asunder. I popped them both into a cyanide bottle, in which they soon died, the ant still

gripping the antenna tenaciously. The butterfly proved to be a specimen of *Catopsilia crocale*, and the edges of its wings were badly frayed with beating against the earth. I did not notice any other ants in the vicinity, but doubtless they would soon have rallied to their comrade's assistance from a neighbouring mango tree which was thickly stocked with them.

Colombo Museum, GEORGE M. HENRY.
July 10, 1913.

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9. "*Bloodsucker*" *Lizards eating small Birds.**—In April last a pair of sunbirds built their nest at the end of a whippy branch of the Japanese Hibiscus in my garden.

One morning on entering the garden I noticed a bloodsucker lizard on the path trying to swallow something unusually large. Close inspection showed it to be a newly-fledged young bird. I made him drop it and found he had eaten the head. I then noticed the sunbird's nest on the ground, containing another young bird, the weight of the lizard having evidently brought it to the ground. I tied it up as well as I could in its original place, and the hen-bird at once began feeding the surviving young one. Half an hour later I saw, what I believe to be, the same lizard crawling out along the twig to the nest; so I killed it.

Haldummulla, W. ORMISTON.
November 8, 1912.

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10. *Length of Life of Butterflies in the perfect stage.**—In breeding experiments with certain species of Mycalesis I have noticed that all the females I put into cages to lay eggs seem to live for about six weeks. They usually take two or three weeks before starting to lay, but, once started, they apparently lay one or two eggs per diem till they die. I fancy they must lay much more freely in a wild state.

Haldummulla, W. ORMISTON.
November 8, 1912.

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* Read before the Ceylon Natural History Society, December 17, 1912.

11. *Some Notes on the Breeding Habits of some Ceylon Snakes and Reptiles.*—The snakes that breed most frequently in captivity are naturally those that take to it most kindly, such as *Tropidonotus stolatus.* The numerous specimens of this snake, which I have kept during the last two years, have produced a very large quantity of eggs, each snake usually averaging about fifteen in number. None of my cobras have ever laid eggs, probably on account of their excitable disposition, and the fact that their cage is considerably smaller in proportion to their size than that of *Tropidonotus stolatus.* The laying period of *Tropidonotus stolatus* is very variable, and extends from the end of April to the middle of September, while the cobra breeds from May onwards.

The python has often been known to breed in captivity, but although I kept a collection of fourteen adult specimens loose in a room for over a year, no eggs were obtained, though one of the snakes, fifteen feet in length, was originally caught in a hole, in May, with twenty-eight eggs, that were on the point of hatching.

Of the ovoviviparous snakes *Trimeresurus trigonocephalus* (the "green polonga") lays about December, and *Ancistrodon hypnale* in September.

The genus Bryophis contains both oviparous and ovoviviparous snakes, but of the Ceylon varieties, *Bryophis mycterizans* is ovoviviparous; only on one occasion has one of my specimens of this species bred, when three young were produced, all dead. *Bryophis pulverulentus* being an uncommon snake, I have been unable to discover whether it is oviparous or not.

A *Vipera russellii* (tic polonga) kept in Colombo, in the course of a week gave birth to 28 young in captivity, all of which died except one, and that and the parent died soon after, probably on account of the snake injuring itself in its struggles when caught, as even then the fœtuses must have been in an advanced stage of development. The young "tics" were of a very dark colour, almost black, the leaf pattern being marked in white lines, which, however, becomes very indistinct as the snake grows larger, when the pattern has a broad dark edging. These young snakes were about 7 in. in length, with the poison apparatus fully developed.

The head of the female tic polonga is smaller and less distinct from the neck than that of the male, and the tail is naturally shorter.

On April 26, a *Helicops schistosus* that had been impregnated in captivity laid thirteen eggs, and remained in a very swollen condition until May 13, the lower portion of the body being swollen with eggs to an extraordinary extent. Two hardened lumps had appeared through the skin on each side of the anal scale at the beginning of May, and on the 13th the snake died. Dissection revealed the presence of nineteen eggs in the ovaries, and that two of the eggs had burst through the skin, on each side of and above the anal. As far as I could discover this was due to the snake being unable to shed its slough, which had thickened over the anal and prevented the extrusion of the eggs. These two batches, thirty-two eggs in all, constitute a record so far as my personal experience of snakes is concerned, though the python, according to Mr. Hagenbeck, may lay as many as one hundred eggs, the incubation lasting two and a-half months.

Two eggs of *Tropidonotus ceylonensis* which I found lying in the open outside a hole, were peculiarly shaped, rather like a curved sausage. The eggs were $1\frac{5}{8}$ in. long and nearly $\frac{1}{2}$ in. broad, a large size for so small a snake, which averages 18 in. in length. The exposure of the eggs to the sun had probably killed the young, as they were found fully developed but quite dead inside; another dead one which had just hatched out was also found.

In the young snakes the yellow collar markings were absent, but the yellow borders to the black vertebral blotches were very distinct. The snakes were $6\frac{1}{2}$ in. in length.

Dipsas forstenii has been impregnated and laid numerous eggs in captivity in the months of August and September, and *Zaminis mucosus* in May, July, and September, though as such a nervous snake as the latter will only breed in a large enclosure, I keep mine loose in a room with the pythons. It is a remarkable example of the "anti-reptilian" appetites of the pythons, that I have never known one to swallow a ratsnake.

Lylindrophis maculatus is ovoviviparous, and in April I found three well-developed fœtuses inside a dead specimen.

Tropidonotus asperrimus lays from May to August; the almost identical species *T. piscator* is said to incubate its eggs, and lay in one clutch containing as many as forty, but as none of my *T. asperrimus* have ever laid, I have had no opportunity of observing this habit.

According to Major Wall the *Dendrophis pictus* is ovoviviparous.

The period between the impregnation of the female snake and the hatching of the eggs is between four and five months—the hatching usually occupying a month or six weeks.

The eggs are usually laid in a hole where decaying vegetation gives off warmth and moisture, and, contrary to common belief, are well protected from the sun, which would soon shrivel up the eggs through their soft skin. The young snake cuts two cross slits in the envelope with a sharp-edged tooth attached to the præmaxillary (in the front of the mouth between the upper jaws). A young *Tropidonotus stolatus*, which I saw hatched, withdrew its head after first seeing daylight, and remained in the egg for about two hours, though it kept looking out at intervals. Young snakes are quite active directly after birth, and retain for some time a distinct slit in the abdomen, covered only by a thin skin, but the ventral shields soon close over it.

To pass on to a few other reptiles. A "talagoya" (*Varanus bengalensis*) caught a week ago has laid (June) seven soft-shelled eggs, of oval shape, while a *Testudo elegans*, in the middle of April, laid four hard-shelled eggs, kicking each egg out of the way with its hind legs as it laid it, to prevent it being broken by the others. The eggs resembled fowls' eggs, but were rounder in form and slightly smaller.

The crocodile lays its eggs in a hole in moist sand at the edge of the water, or in a deep hole in a bank, large enough to contain itself. When the vicinity of the "tank" it frequents is much disturbed by human beings, it will often travel far to rock holes and lay its eggs there. The hatching period is very irregular, and varies from July to September, and the eggs are laid with a hard shell, which gradually softens to a

leathery consistency. At Kokobe, in the Anuradhapura District, I came across a batch of crocodile's eggs at hatching time, in a sand hole by a river. Some of the young crocodiles had already escaped, and had entered the water with the egg-shells still attached to them by the navel cord, though the water soon released them. Others were still coiled round in their eggs, or lying half in and half out. On being disturbed they ran about with much activity, uttering low whines, and protesting with angry hisses. The parent was floating in the water not far off, but did not show much anxiety on account of her offspring, and even those young that had escaped into the water did not approach her.

Altogether I obtained about 24 of these young crocodiles, but they all died off within four months—probably the meat and fish diet I gave was indigestible for such young ones, and they no doubt required as food such small animal life as they would have found in their native jungle stream.

A. F. ABERCROMBY.

Anuradhapura, June, 1913.

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12. *How a Crocodile feeds.*—The crocodile usually seizes its food with a lateral snap, and raising its head out of the water with the snout pointing straight upwards, snaps and shakes the morsel until it succeeds in jerking it into its throat. Should any portion (for instance the claw of a bird) catch in the side of its mouth, it either shoves it in with its hind leg or breaks it off with violent slaps of the tail. If the food is too large and the reptile in danger of choking, it returns the food to its mouth by a muscular contraction of its throat, and will then bite and shake it about until a piece is torn off. The teeth of the crocodile are only used for tearing its food, which it never really masticates. In the case of live animals, the crocodile will hold its prey under the water until drowned. The crocodile's nostrils are at the tip of the snout, and while its prey is being drowned the nasal passage comes into close connection with the trachea, and thus the crocodile is able to breathe without swallowing any water.

After the prey is dead the crocodile tears off the flesh by catching hold of it with its teeth and giving violent jerks of the body. Sometimes, however, it prefers to leave the meat until putrified.

A. F. ABERCROMBY.

Anuradhapura, May 27, 1913.

THE CEYLON NATURAL HISTORY SOCIETY.

Sixth General Meeting.

THE Sixth General Meeting of the Society was held in the Colombo Museum on Friday, May 30, 1913. Dr. Andreas Nell presided in the absence of the President.

Mr. C. Hartley read a Paper on " Stone Implements of Ceylon."*

Dr. Pearson gave an account of some of the faunistic results of the recent inspection of the Ceylon Pearl Banks. Numerous specimens were exhibited.

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* Published in full on page 117 of the present number of " Spolia Zeylanica."

L'IMAGO DE L'EUTERMES LACUSTRIS DE CEYLAN.

Par E. BUGNION.

(Avec deux planches.)

J'AI décrit l'année dernière dans la Revue suisse de Zoologie le soldat, l'ouvrier, la nymphe, la reine et le roi de l'*Eutermes lacustris*, mais n'ai rien pu dire de l'imago, ne la connaissant pas encore à cette époque.

Cette lacune a dès lors été comblée, grâce à une heureuse trouvaille de Mr. Oscar John de St. Pétersbourg.

Mr. John a, au cours d'une excursion à Hantana, rencontré un nid d'*E. lacustris* qui renfermait, entre autres, des imagos en très grand nombre. Le même observateur ayant bien voulu me céder quelquesuns de ces insectes, je me trouve actuellement en mesure de les décrire.

Hantana est une chaîne de collines qui s'étend au sud de Peradeniya sur une longueur de plusieurs milles et s'élève à une altitude de 3,000 pieds. Les sommets sont rocailleux, formés de grosses pierres superposées. De grandes herbes qui masquent des fentes traîtresses rendent leur accès assez pénible. En dessous des sommets, sur les flancs de la montagne, se trouvent des bouquets de jungle qui abritent d'intéressants Termites. C'est là que le Prof. Escherich a découvert en 1909 l'*Eutermes hantanae* (décrit par Holmgren). C'est là que j'ai trouvé moi-même dans un tronc pourri imbibé d'humidité une belle colonie de *Termitogeton umbilicatus*, Hag.*

Le nid d'*E. lacustris* observé par Mr. John était un magnifique nid de carton de bois, brun foncé, régulièrement arrondi à la surface, placé dans la fourche d'un arbre à 30 pieds environ au dessus du sol. (Photographie ci-jointe.)

Ses dimensions étaient : pourtour 76 cm., longueur 26, largeur 20, hauteur 16. A l'intérieur se voyaient de nombreuses

* Cette curieuse espèce a été observée dès lors dans la jungle de Kotua (low-country) à 8 milles au nord de Galle et en plus grand nombre (5 colonies) sur la colline couverte de jungle qui se trouve au dessus Hatton (4,500 pieds).

anfractuosités pareilles aux cavités d'une éponge. Un cordon brunâtre (tunnel) montant le long de l'arbre à la surface de l'écorce, servait au va-et-vient des Termites.

Ayant fait "cueillir" la termitière par deux coolies, Mr. John eut la satisfaction de la rapporter intacte à Peradeniya et de pouvoir à loisir étudier ses habitants. C'était en décembre 1912. Le nid placé dans la fourche d'un arbre près du laboratoire entomologique a été quelque temps après malheureusement détruit par un orage. Ce dernier renseignement m'a été donné par Mr. E. Green.

L'observation de Mr. John est, comme on voit, instructive à divers égards. Elle montre que l'*E. lacustris* peut, dans certaines circonstances, faire un nid de carton ligneux suspendu à l'air libre ;* elle prouve au surplus que ladite espèce n'habite pas exclusivement le low country et ne se trouve pas nécessairement au bord des lacs, mais peut occasionnellement se rencontrer sur les collines.†

Description.—Longueur 7½ à 8 mm., avec les ailes 14½ à 16, ailes 12 à 13½, abdomen 4 à 5.

Tête d'un brun foncé assez brillant (presque noire), avec le clypeus, les pièces buccales et les antennes d'un brun jaunâtre. Thorax et tergites abdominaux brun sépia avec une pubescence jaune, courte et serrée. Dessous du corps plus clair. Parties membraneuses de l'abdomen blanchâtres, garnies de

* Certains Termites qui vivent habituellement dans un arbre creux et se bornent à protéger leur demeure au moyen d'un opercule de carton de bois, peuvent, lorsque l'arbre n'offre pas de cavité convenable, construire de toutes pièces un nid de carton appendu à l'extérieur. J'ai publié moi-même une observation de ce genre relative à l'*E. monoceros* (le Termite noir de Ceylan, observations nouvelles. Bull. Soc. Vaud. Sc. Nat., Vol. 47, 1911, p. 423)—Les nids de carton appendus à l'extérieur des arbres, exceptionnels pour les *E. monoceros* et *lacustris* sont, comme on sait, la demeure ordinaire de certains *Eutermes* d'Afrique, de Madagascar, de Bornéo et du Brésil.

† J'ai observé moi-même durant mon séjour à Talgaswella (février 1913) un nid d'*Eutermes lacustris* semblable à celui qui a été capturé par Mr. John. Ce nid fait de carton de bois brun foncé mesurait 45 cm. de longueur, sur 20 de largeur et 16 de hauteur. Il n'était pas attaché à un arbre, mais reposait sur le sol au pied d'un albizia. La surface était couverte d'une lame brune assez dure ; on voyait à l'intérieur de nombreuses cavités séparées par des cloisons. J'y trouvai, outre les ouvriers et les soldats, un grand nombre de nymphes, mais aucune imago complète. La reine et le roi n'ont pas été observés. Talgaswella est un estate du low-country situé à 30 milles environ au nord de Galle.

poils serrés, ailes légèrement enfumées, avec le bord antérieur d'un jaune assez vif. Pattes jaunâtres, rembrunies au bout des cuisses et à la base des tibias.

Tête en ovale allongé, légèrement aplatie entre les yeux. Yeux gros, arrondis. Ocelles rapprochée des yeux, très convexes. Fontanelle oblongue, élargie d'arrière en avant, son bord antérieur concave, formant (au niveau de la suture) un v très ouvert.

Antennes de 15 articles, brunâtres, rembrunies vers la base, avec les articulations jaune paille : 3 + 4 ensemble un peu plus longs que 2 ; 3 un peu plus court et plus étroit que 2 ; 4 plus gros que 3 ; 3 un peu plus étroit que 4 ; les suivants graduellement un peu plus longs.

Clypeus $2\frac{1}{2}$ fois plus large que long, convexe, avec un sillon médian. Proclypeus membraneux, transparent; son bord antérieur en forme de v renversé largement ouvert.

Labre en forme de pelle, rétréci à la base, puis légèrement élargi vers le milieu; sa face dorsale garnie de quelques poils.

Mandibule gauche (Fig. 3), outre la dent apicale, avec une 2me dent acérée prolongée par un tranchant un peu convexe, une 3me dent plus petite placée au bout postérieur de ce tranchant, une 4me dent, forte, triangulaire,* séparée de la 3me par une petite incisure, prolongée jusqu' à la base par un bord sinueux.

Mandibule droite, ontre la dent apicale, avec une 2me dent de même force, une 3me dent large, obtuse, à bord sinueux séparée de la précédente par une incisure en v, une échancrure plus large (en demi-lune), enfin une apophyse basale, dont le bord presque droit, proéminent en dedans, offre une douzaine de crénelures. Menton $1\frac{1}{2}$ fois plus long que large, rétréci d'arrière en avant; son bord postérieur légèrement arrondi.

Appareil maxillo-labial bien développé; peigne du lacinia formé d'une douzaine de cils. Langue en forme de poire, élargie en avant.

Pronotum non relevé en avant, un peu plus étroit que la tête au niveau des yeux, d'un tiers plus large que long,

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*La 4me dent qui caractérise la mandibule gauche se retrouve, plus développée, chez *E. hantanae*.

rétréci d'avant en arrière ; ses angles antérieurs arrondis, le bord postérieur largement arrondi, sans échancrure.

Ecailles alaires d'un brun foncé, les antérieures plus grandes que les postérieures.

Nervure costale d'un jaune doré, rembruni à la base ; radius jaune, bordé postérieurement d'un léger liseré noirâtre ; médiane grêle, atténuée (parfois bifurquée) vers l'apex, éloignée du radius, rapprochée de la médiane, avec 3 ou 4 branches latérales fines traversant obliquement le vaste champ radio-médian ; cubitus grele, atténué vers l'apex, avec 11 branches, dont les 7 premières épaissies, de couleur brunâtre. Les bords des ailes sauf dans le tiers interne, garnis de petits poils ; quelques poils clairsemés à la surface. Observée au microscope, l'aile entière se montre couverte de rugosités ponctiformes très serrées.* L'aile postérieure, très semblable à l'antérieure, diffère seulement en ceci que la médiane, au lieu de s'insérer au bord de l'écaille, se détache du radius en dehors de celle-ci.

Pattes assez velues ; une épine plus forte (interne) au bout du tibia ; 3me article du tarse proéminent en dessous du 4me. Les pattes postérieures n'atteignent pas tout à fait le bout du corps.

Disposition des sternites abdominaux chez le mâle et la femelle.

L'imago de l'*E. lacustris*, par le fait que le sternites se détachent en brun foncé sur un fond blanchâtre, montre plus nettement que d'autres espèces les caractères externes qui différencient les deux sexes.

Tandis que la face dorsale de l'abdomen (formée de 10 tergites) est identique chez le ♂ et la ♀, la face ventrale est au contraire très différente.

Mâle (Fig. 5).—Face ventrale de l'abdomen composée de neuf sternites : 1 (placé en arrière des hanches postérieures) un peu plus petit que 2 ; 2, 3, 4, 5 et 6 à peu près identiques ; 7 (dans le sens antéro-postérieur) deux fois plus court que 6 ; 8 entier, plus court et plus étroit que 7 ; 9 (terminal) divisé en

* L'aile de l'*E. singaporiensis* paraît d'après la description de Haviland semblable à celle de l'*E. lacustris*, avec cette différence que chez *E. singaporiensis*, le cubitus donne 8 branches au lieu de 11.

deux plaques triangulaires. Papilles pilifères placées des deux côtés de 9.

Femelle (Fig. 4).—Face ventrale de l'abdomen composée de huit sternites : 1 placé comme chez le ♂, un peu plus petit que 2 ; 2, 3, 4 et 5 à peu près identiques ; 6 (dans le sens antéro-postérieur) beaucoup plus long que les précédents, formant une *grande plaque* à bord postérieur arrondi ; 7 composé de quatre petites pièces triangulaires, les deux de droite assez écartées des deux de gauche ; 8 (terminal) divisé en deux plaques triangulaires, semblable au 9e du mâle. Papilles pilifères placées des deux côtés de 8.

Les traits distinctifs des sternites abdominaux des imagos ♂ et ♀ ont été indiqués par J. Feytaud pour *Leucotermes lucifugus* (Arch. d'anat. micr. Paris, juin, 1912). Je les ai étudiés moi-même chez *Termes Horni* (Rev. suisse de Zoologie, Genève, 1913).

Précédemment déjà Haviland a signalé chez divers *Termes* et *Eutermes* (imagos), la plaque de dimensions plus grandes qui s'observe chez la ♀ au côté ventral. La forme de cette plaque est pour plusieurs espèces soigneusement indiquée (Journ. Linn. Soc., London, Vol. 26, 1898).

Je faut remarquer toutefois que, dans les descriptions de cet auteur, la grande plaque, an lieu d'être désignée sous le nom de 6me sternite, est appelée " ventral plate of the 7 th. abdominal segment."

Haviland admet, semble-t-il, que les plaques ventrales des Termites répondent aux plaques dorsales tandis qu' en réalité une telle concordance n'existe pas.

Mes figures 4 et 5, exactement dessinées à la chambre claire d'après des préparatious au baume, montrent à la base de l'abdomen une partie membraneuse qui, chez les Termites actuels paraît rattachée an métathorax, mais qui chez les formes ancestrales, répondait vraisemblablement au tergite 1. Cette région, désignée dans les figures par la lettre *o*, est en grande partie cachée sous la 3me paire de hanches et sous les expansions latérales qui en dépendent. La discordance qui d'observe dans le nombre des sternites et des tergites s'explique par le fait que, chez les Termites actuels, aucun sternite ne se développe à ce niveau.

Nid d'Eutermes lacustris observé à Hantana. D'après une photographie de Mr. O. John

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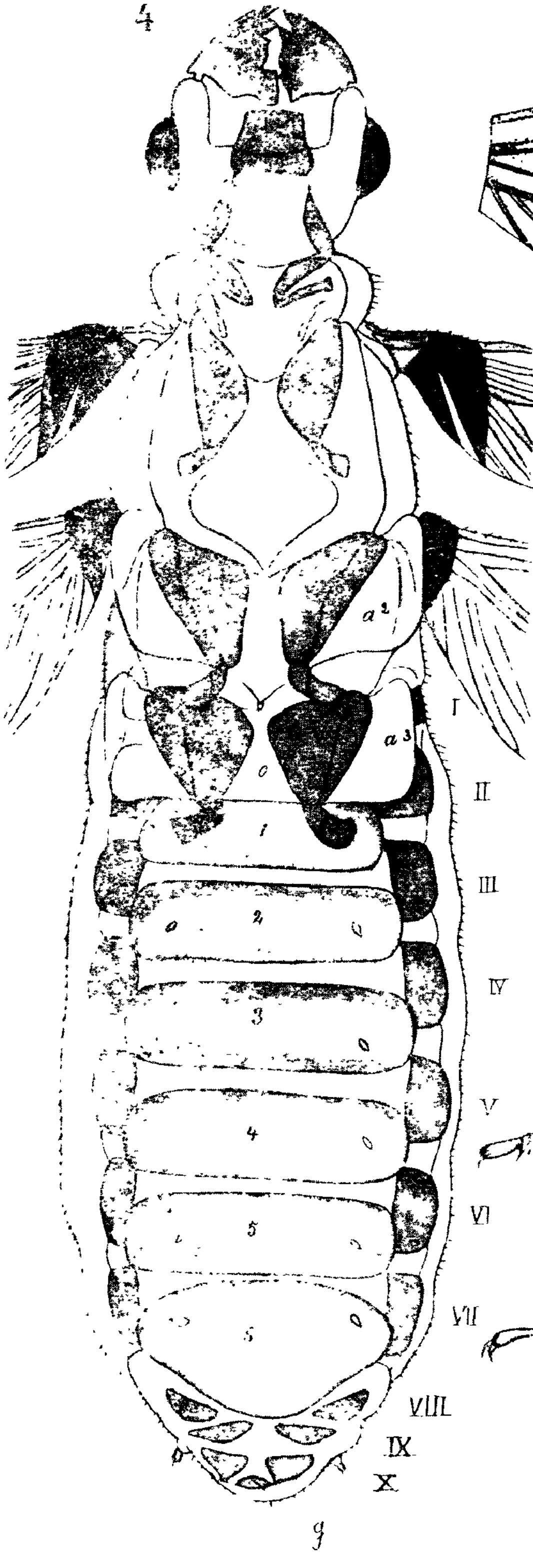

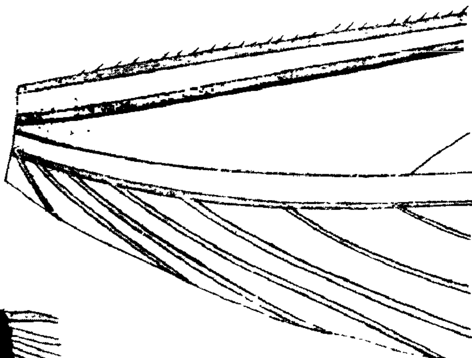

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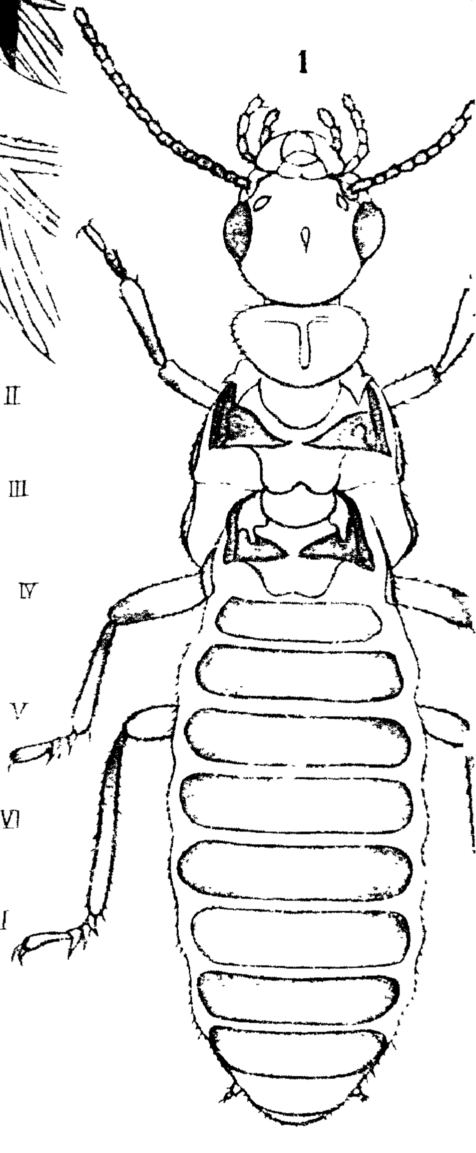

I. IMAGO DE

un tache claire en ovale allongé. Clypeus convexe, $2\frac{1}{2}$ fois plus large que long, avec un sillon médian. Proclypeus membraneux, de moitié plus court que le clypeus. Labre en forme de pelle, rétréci à la base, élargi vers le milieu (semblable àcelui de l'ouvrier) ; sa face dorsale garnie de quelques poils.

Antennes de 15 articles : 3 + 4 ensemble à peine plus longs que 2 ; 3 un peu plus court et plus étroit que 4 ; 5 un peu plus petit que 4, de même grosseur que 3 ; les suivants un peu plus gros, ovoïdes.

Mandibule gauche, outre la grosse dent apicale, avec une 2me dent presque aussi forte prolongée par un tranchant droit ; ce dernier s'arrête à une petite dent (3me) ; après celle-ci une petite incisure, puis une 4me dent très forte en forme de lancette, une échancrure large, enfin une 5me dent obtuse, limitant en dedans l'échancrure d'insertion de l'adducteur.

Mandibule droite, outre la grosse dent apicale, avec une 2me dent triangulaire presque aussi forte, une 3me dent plus petite séparée de la précédente par une échancrure, enfin une apophyse basale mousse, proéminente, à contours sinueux.

La denture de la mandibule gauche, très caractéristique, se retrouve identique chez l'ouvrier.*

Appareil maxillo-labial et palpes bien développés, de la forme ordinaire.

Pronotum un peu plus étroit que la tête au niveau des yeux, transverse, d'un tiers au moins plus large que long, légèrement trapézoïde (sa plus grande largeur un peu en avant du milieu), son bord antérieur droit, non relevé au dessus de la tête, ses angles antérieurs arrondis, le bord postérieur avec une petite échancrure, les bords latéraux faiblement courbés.

Ecailles alaires d'un brun foncé, hérissées de quelques poils, les postérieures un peu plus petites que les antérieures. Ailes légèrement enfumées. Nervure costale d'un brun jaunâtre, plus faible vers le bout. Radius, à partir du milieu, avec un bande sous-jacente de couleur jaunâtre. Médiane

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* **L'imago,** semblable à l'ouvrier par la **structure** des **mandibules, diffère cependant** de ce dernier par la longueur des antennes (15 **articles au lieu de** 13) et par la forme très différente de l'abdomen et du **thorax. C'est vraisemblablement** pour **donner** à **la tête un point d'appui plus** solide que le bord du **pronotum** se relève chez l'ouvrier.

grêle, atténuée vers l'apex, trois fois plus distante du radius que du cubitus au milieu de l'aile, privée de branches antérieures, avec trois rameaux postérieurs qui remplacent chez cette espèce les branches fournies d'ordinaire par le bout du cubitus. Cette disposition, très caractéristique, suffit à distinguer l'imago de l'*E. hantanae* de celle des autres *Eutermes* Singhalais. Cubitus raccourci, donnant seulement 6–7 branches. Son extrémité, infléchie en arrière, rejoint le bord postérieur un peu en dehors du milieu.

Bord de l'aile garni de petits poils plus nombreux vers l'apex. Quelques poils clairsemés à la surface.

Observée au microscope, l'aile entière montre des rugosités ponctiformes assez serrées.

L'aile antérieure diffère de la postérieure en ce que la nervure médiane se détache de l'écaille, tandis que dans l'aile postérieure la médiane se détache du radius (un peu en dehors de l'écaille). Le cubitus de l'aile postérieure est relativement un peu plus court.

Pattes assez velues. Une épine plus forte (interne) au bout de chacun des tibias.

Abdomen (chez mon exemplaire) court et étroit, à bords parallèles. Papilles sétifères de grandeur ordinaire. Les pattes moyennes atteignent le bout du corps, les postérieures le dépassent de beaucoup.

Ouvrier (Fig. 3 et 4).—Longueur 4–4$\frac{1}{3}$ mm.

Blanchâtre avec les articulations et les dents des mandibules, les baguettes des adducteurs et les dents des maxilles d'un brun plus ou moins foncé.

Intestin d'un gris brunâtre, visible par transparence à l'intérieur de l'abdomen.

Tête presque glabre, corps hérissé de poils rigides plus nombreux vers le bout.

Tête un peu rétrécie d'avant en arrière, presque pentagonale (Holmgren), avec la plus grande largeur en avant des antennes.

Sutures céphaliques non visibles (différence marquée d'avec *E. lacustris* qui a une suture en T de couleur claire nettement dessinée).

Clypeus fortement convexe, 2½ fois plus large que long, avec un sillon médian. Les insertions musculaires formant à la face profonde (sur les préparations au baume) deux dessins étoilés.

Proclypeus membraneux, de moitié plus court que le clypeus.

Labre en forme de pelle, rétréci à la base puis légèrement dilaté en arrière du milieu. Deux lignes de rugosités ponctiformes visibles par transparence comme chez les Termites en général.

Antennes aussi longues que la tête avec les mandibules, formées de 13 articles : 3 un peu plus court que 2, 4 de même longueur et, ainsi que les suivants, un peu plus épais que 3.

Mandibule gauche, outre la grosse dent apicale, avec une 2me dent un peu moins forte prolongée par un tranchant droit, une 3me dent très petite au bout postérieur de ce tranchant, une échancrure en v, une 4me dent très forte en forme de lancette (semblable à celle de l'imago), puis une 5me dent obtuse, limitant en dedans l'échancrure d'insertion de la baguette. Mandibule droite, outre la grosse dent apicale, avec une 2me dent moins forte, une 3me dent très petite, séparée de la précédente par une inciture en v, une échancrure plus large, enfin une apophyse basale fortement proéminente, à contours sinueux. Echancrures maxillaires petites, reportées en avant. Menton quadrangulaire, mobile (non soudé).

L'appareil maxillo-labial offre la disposition habituelle. Pronotum petit, de moitié plus étroit que la tête, d'un tiers plus large que long, rétréci d'avant en arrière, son bord antérieur fortement relevé derrière la tête, non échancré. Mesonotum plus large que le pronotum, ses bords plus arrondis; metanotum plus large que le mesonotum ; son bord postérieur relevé de manière à s'adapter au 1er segment abdominal.

Pattes transparentes, hérissées de poils courts. Deux épines plus fortes (internes) au bout de chacun des tibias. Tibias renflés dans leur partie moyenne, amincis aux deux bouts. Une coche bien marquée au premier quart. Bord ventral du 3me article tarsien prolongé en dessous, comme chez les *Eutermes* en général.

Abdomen ovoïde, fortement renflé; les papilles sétifères bien développées. L'abdomen, de structure membraneuse, ne se décompose pas en tergites et en sternites nettement visibles.

Observés au microscope, les parties latérales (transparentes) de l'abdomen montrent des rugosités très fines, disposées en séries longitudinales nombreuses et serrées. Le thorax et l'abdomen de l'ouvrier sont en somme plus semblables à ceux du soldat qu' à ceux de l'imago.

Larves d'ouvriers.—Plusieurs larves blanches, longues de $1\frac{1}{2}$ à 2 mm. montraient distinctement tous les caractères de l'ouvrier (absence de corne frontale, mandibules dentées, etc.) Les antennes étaient, chez la plupart, composées de 12 articles.

L'exemplaire dessiné fig. 5 montre par transparence les trois ganglions thoraciques relativement très gros, rapprochés les uns des autres et d'une manière plus vagu: les six ganglions abdominaux. Le bout de l'abdomen porte deux styles médians et deux cerque latéraux à proport on plus développés que chez l'adulte.

Soldat (Fig. 6–11).—Longueur $3\frac{1}{2}$–4 mm. Tête avec la corne 1·8; corne seule 0·75; largeur de la tête 0·98.* Tête jaune paille, avec les bords latéraux et le bec rembrunis. Corps blanchâtre, garni de poils rigides. Pattes transparentes hérissées de poils courts. Les intestins vus par transparence à l'intérieur de l'abdomen forment une masse noirâtre partiellement masquée (comme déchiquetée) par les masses blanches du corps graisseux.

La tête, vue d'en haut, est régulièrement arrondie puis prolongée en forme de cône du côté du bec. La corne, d'un tiers environ plus courte que la tête, est droite, cylindrique, avec l'extrémité conique, garnie de quelques po ls. Une légère dilatation se montre à droite et à gauche au—dessus des insertions des deux antennes.

Vue de profil, la tête offre une ligne fronto-nasale légèrement relevée en arrière de la base du bec, puis un peu déprimée en avant du front. Le front lui-même, un peu convexe, ne se

* Ces mesures out été prises à l'aide de l' oculaire micrométrique.

trouve pas dans le plan de la ligne fronto-nasale, mais paraît légèrement relevé au dessus de celle-ci. L'ampoule glandulaire est située dans la partie supérieure et postérieure de la tête. Observée par transparence (sur une préparation an baume), elle montre un arrière-fond de forme ovoïde appendu en dessous du segment supérieur. L'appareil entier est entouré d'une épaisse couche de muscles circulaires et longitudinaux dont les fibres se croisent à angles droits. Le canal excréteur légèrement dilaté à l'origine (partie contractile) offre ensuite un calibre régulier, à peu près cylindrique, et une direction rectiligne jusqu' au bout du bec. Observée à un fort grossissement, sa paroi offre une fine striation dans le sens de la longueur.

N.B.—Les sujets tués dans l'alcool, le chloroforme, etc. montrent leur ampoule à l'état cont acté. Observée avant l'expulsion du contenu, celle-ci offrirait des dimensions bien plus grandes.

Antennes grêles et allongées (longueur 1·5 mm), formées de 12 articles : 3 de moitié plus long que 2 ; 4 plus court que 3, un peu plus long que 2.

Le labre, difficile à voir, se montre sur la tête observée de profil comme une saillie convexe et sur la tête vue d'en haut (fig. 8), comme une proéminence à contour arrondi dépassant la base du bec des deux côtés.

Le tentorium (fig. 9 et 10) est une lame quadrangulaire prolongée par quatre piliers. Il y a deux piliers postérieurs courts fixés au bord antérieur de la lame basilaire et deux piliers antérieurs longs aboutissant en dedans de l'anneau qui soutient l'antenne. L'orifice laisse comme toujours passer l'oesophage et les connectifs nerveux. Le ganglion sous-oesophagien, de forme ovale, est placé entre le tentorium et le menton. Les muscles abducteur et adducteur de l'antenne s'insèrent sur la face dorsale du tentorium.

Les échancrures maxillaires, relativement assez grandes, offrent un petit tubercule sur lequel s'articule le cardo de la maxille.

Les mandibules (fig. 9 et 10), bien différentes de celles de l'*E. monoceros*,* sont représentées par deux pièces à peu près triangulaires venant, dans la position fermée, en contact par leur sommet. Ce dernier, formé d' une chitine épaissie, est tronqué obliquement. L'articulation de la mandibule (fig. 9) correspondant à l'articulation mandibulaire ventrale des Termites en général, se trouve sur le bord de l'échancrure maxillaire un peu en arrière du cadre de l'antenne. Le muscle adducteur, relativement très faible, est à peine plus épais que l'abducteur.

Le menton (fig. 11), plus large que long à la base, rétréci dans sa partie antérieure, s'articule sur deux baguettes chitineuses qui renforcent les bords latéraux du trou occipital. (Ces baguettes s'observent également chez les autres *Eutermes.*) Les maxilles sont petites, la 2^me^ dent du lacinia à peine visible, le peigne formé de 6 à 7 cils, le galea relativement un peu plus grand.

Il y a, comme chez les Termites en général deux glosses et deux paraglosses, insérés sur le bord antérieur de la ligule et deux palpes labiaux composés de trois articles.

La langue (hypopharynx) petite, en forme de poire allongée, est comme toujours fixée à la face dorsale de la ligule.

Les contours de la cavité buccale peuvent être distingués sur la figure 7 (vue de profil) ainsi que ceux du pharynx et de l'oesophage. Thorax petit, ensellé. Bord antérieur du pronotum relevé derrière la tête, non échancré. Bord postérieur du metathorax relevé de façon à s'adapter au 1^er^ segment abdominal.

Abdomen renflé, ovoïde, de structure membraneuse (tergites et sternites indistincts).

Pattes grêles et allongées. Tibias élargis dans leur partie moyenne, rétrécis vers les bouts. Une coche bien marquée à

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* Les *Eutermes* de Ceylan (soldats) peuvent, suivant la forme des mandibules, être répartis en 3 groupes :—

(1) Mandibules formées d'une lame aplatie, tranchante, prolongée en avant par une épine (*E. monoceros* Koen., *lacustris* Bug., *Escherichi* Holm., *ceylonicus* Holm., *Horni* Wasm.

(2) Forme intermédiaire avec une épine courte insérée obliquement (*E. longicornis* Holm.).

(3) Mandibules plus ou moins triangulaires dépourvues d'épine (*E. rubidus* Hav. grand et petit soldat, *hantanae* Holm., *Kotuae* Bug.).

la jonction du quart supérieur et des ¾ inféri... épines plus fortes (internes) au bout de chaque... inférieur du 3me article tarsien, comme chez les... général, fortement prolongé.

Explication des Figures.

Planche XXIV.

Fig. 1.—L'imago. × 13.

Fig. 2.—Tête et pronotum de l'imago. × 31.

Fig. 3.—L'ouvrier vu de côté. × 23.

Fig. 4.—Tête de l'ouvrier, préparation au baume. × ... L'appareil maxillo-labial à été enlevé afin de rendre les dents des mandibules plus apparentes.

Fig. 5.—Larve d'ouvrier longue de 1·8. × 37. Les antennes ont 12 articles. On voit par transparence la chaîne des ganglions ventraux.

Planche XXV.

Fig. 6.—Le soldat vu de côté. × 31. On distingue par transparence les six ganglions abdominaux.

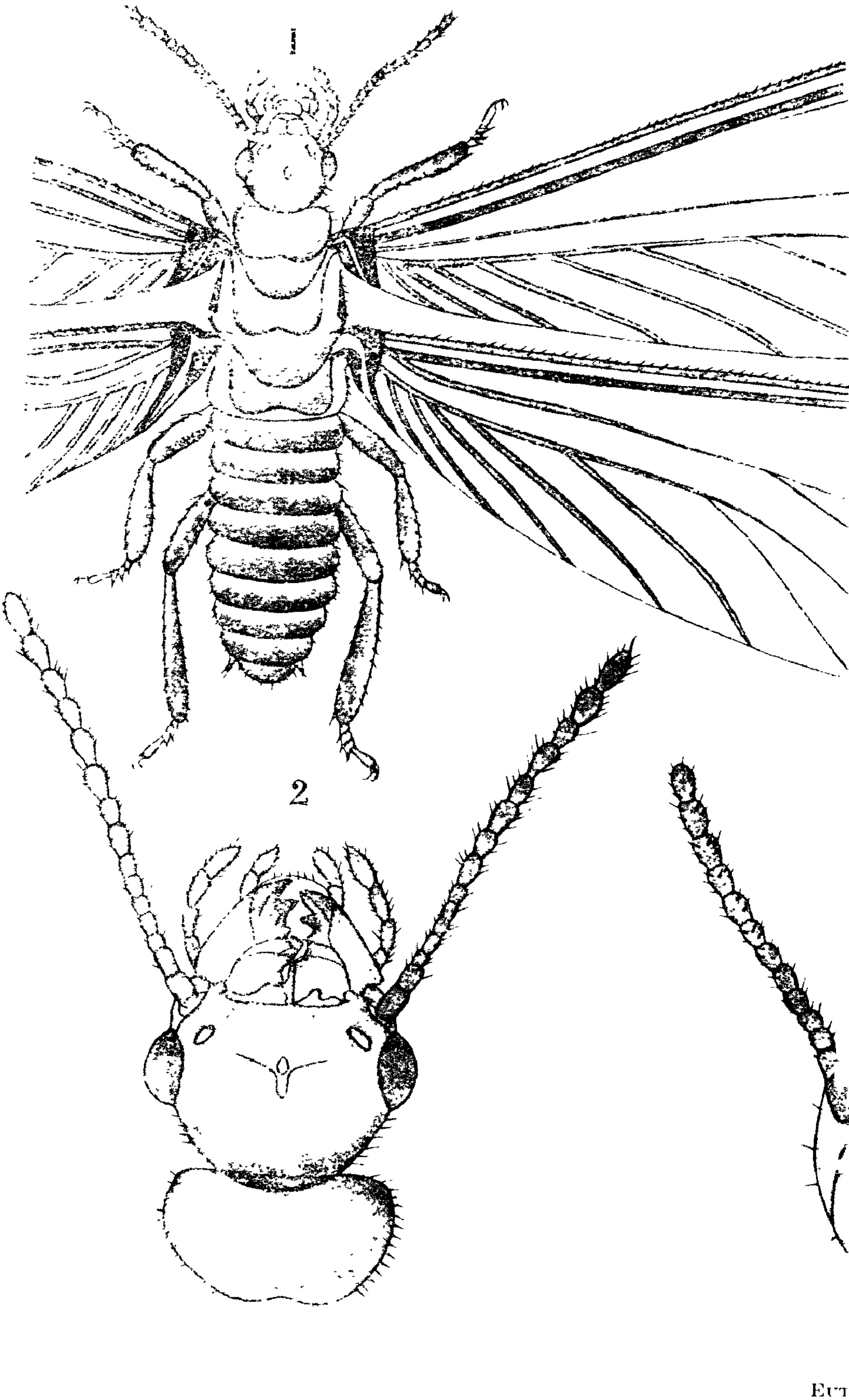
Fig. 7.—Tête et thorax du soldat vus de côté. × 49. On voit par transparence l'ampoule glandulaire et le canal excréteur. ... pharynx et l'oesophage qui étaient remplis de débris de bois ... noir opaque) ont pu, grâce à cette circonstance, être exactement dessinés.

Fig. 8.—Tête du soldat, vue d'en haut, avec l'ampoule glandulaire et le canal excréteur. × 49. Les saillies qui se voient des côtés de la base du bec, en dedans des maxilles, ... deux bords du labre.

Fig. 9.—Tête du soldat avec les mandibules rapprochées. × ... cadre articulaire de l'antenne, *e* échancrure maxillaire ... l'articulation du cardo, *l* insertion du labre, *m* mandibule, ... articulation, *o* trou occipital, *t* tentorium.

Fig. 10.—Tête du soldat. × 49. Mandibules écartées l'une de l'autre (luxées) au moyen des aiguilles.

Fig. 11.—Tête du soldat. × 49. L'appareil maxillo-labial préparé et remis en place.



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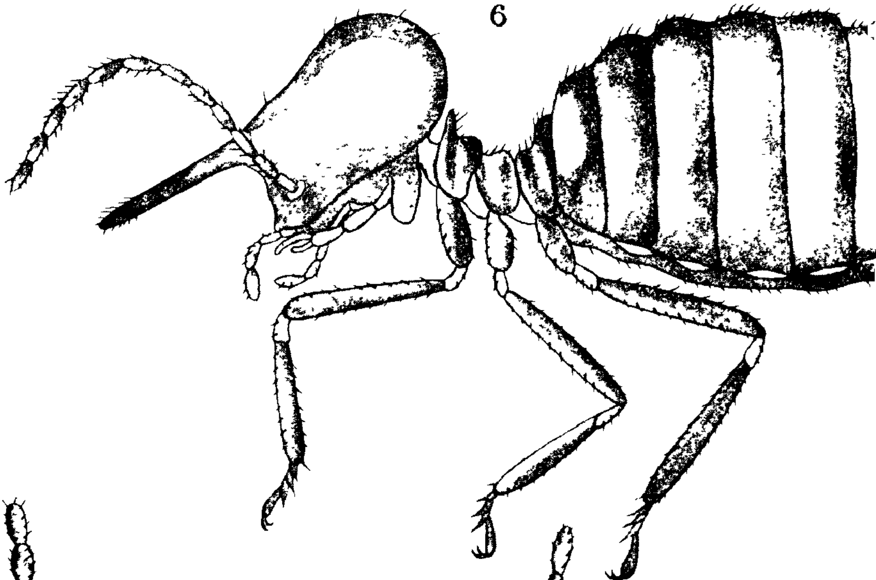

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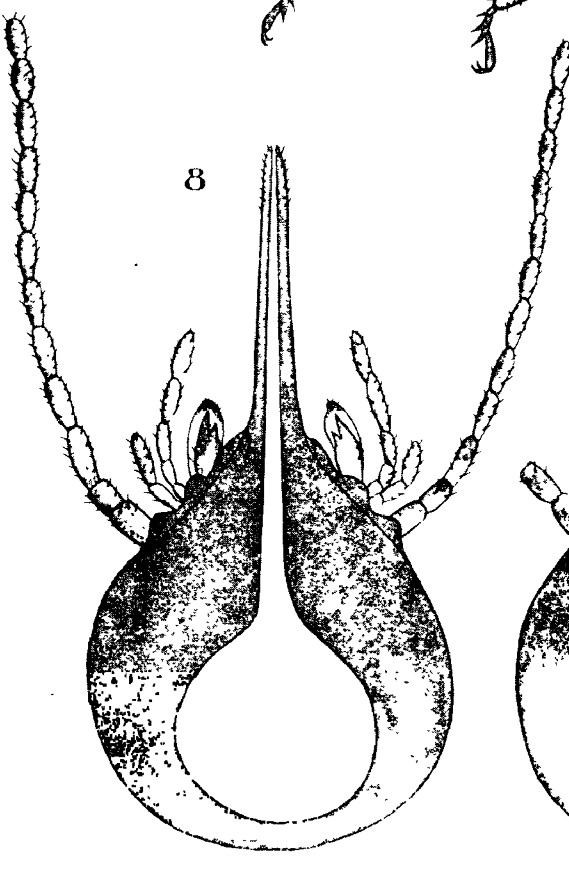

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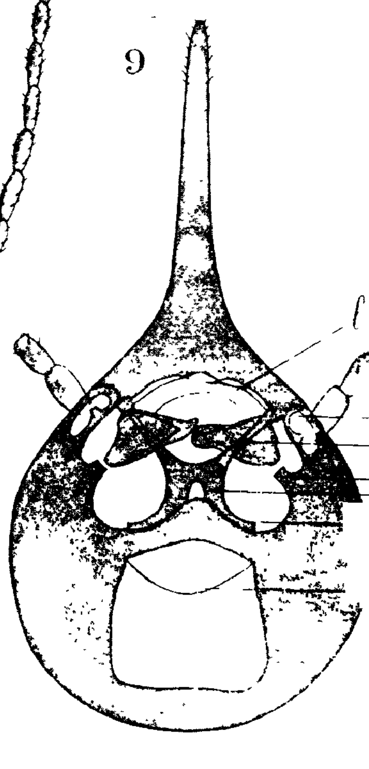

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The genus *Holothuria*, as it is at present understood, will be composed of three sub-genera—(1) *Bohadschia*, to which such a form as *Holothuria marmorata* belongs; (2) *Halodeima*, which will include *Holothuria atra* and its allies; and (3) *Thymiosicya*, of which *Holothuria impatiens* may be regarded as the type. The genus Mülleria will be divided into two sub-genera—(1) *Actinopyga*, including such forms as *Mülleria miliaris*; and (2) *Argiodia*, to which *Mülleria maculata* and its allies belong.

Diagrammatically the proposed changes may be represented as follows :—

	Sub-genera :—	
Genus *Holothuria*	*Bohadschia* *Halodeima* *Thymiosicya*	Genus *Holothuria* sens. nov.
Genus *Mülleria*	*Actinopyga* *Argiodia*	

There are only four characters of any taxonomic value in the genus. These are (1) the arrangement of the ambulacral appendages; (2) the nature of the spicules; (3) the presence or absence of anal teeth; and (4) the structure of the calcareous ring. The number and arrangement of the tentacles, Polian vesicles, and stone canals are variable characters even within the limits of a single species. This is also true of the Cuvierian organs.

Ambulacral Appendages.

The ambulacral appendages show considerable variation within the genus both as regards the kinds of appendages and also their distribution.

It is difficult to say whether any members of the genus are supplied with true pedicels only, although many authors have described such species, and Ludwig gives this character in his diagnosis of the genus Holothuria. Most workers at the group have not examined living specimens of the forms they

have described, and in many cases it is absolutely impossible to distinguish a true pedicel from a papilla, except in a living specimen. Many so-called pedicels have the appearance of a true pedicel, but they are not used by the animal as anchoring or locomotory organs. The distinction is easily seen in the living form, and I do not remember having seen a living Holothurian in which the dorsal appendages to any great extent had the power of attaching themselves to a foreign surface. The sub-genus *Bohadschia* is said by many authors to have true pedicels all over the body. After examining a living specimen of *Bohadschia vitiensis* I said: "The pedicels are irregularly scattered, and the sucking discs are apparently not well developed, since the animal does not appear to use them much."*

In many forms true pedicels are present on the trivium, and the bivium is covered with papillæ which may have a cylindrical shape and a well-developed sucking disc, or may be conical and may be devoid of sucking discs. In many cases true pedicels may be scattered among the dorsal papillæ.

Again, some species have no true pedicels, and these forms are more highly specialized than those which have pedicels on the trivium.

The absence or presence of pedicels appears a reliable means of separating the two sub-genera *Halodeima* and *Thymiosicya.*

Nature of the Spicules.

The spicules in the genus may consist in the simplest forms of dichotomously branched "rosettes." It is easy to conceive how these may give rise first to perforated plates and later to "buttons" and "tables." Those forms possessing tables and buttons may be regarded as more highly specialized than those in which the spicules are in the form of "dichotomous rods" and "rosettes."

* *Spolia Zeylanica*, Vol. IX., Part XXXIV., p. 159.

Calcareous Ring.

The primitive aspidochirote calcareous ring was composed of ten simple pieces (five radials and five inter-radials) without anterior or posterior prolongations (Pl. XXVI., fig. 1). The radial longitudinal muscles were attached to the radial pieces, and in consequence these were notched anteriorly for the insertion of the muscles, and because of this the radial pieces were larger and stronger than the inter-radials (Pl. XXVI., fig. 2). The tentacular ampullæ arose near the anterior end of the calcareous ring, and in consequence the anterior end of the ring became scooped out at twenty places (ampullary notches) corresponding to the twenty tentacles (Pl. XXVI., fig. 3). Such a type is seen in the sub-genera *Actinopyga* and *Bohadschia* (Pl. XXVI., figs. 4 and 5). In *Bohadschia vitiensis* the inter-radials do not project so far forward as the radials. This difference gradually becomes emphasized, and at the same time the ampullary notches become less and less marked, until in the sub-genera *Argiodia*, *Halodeima*, and *Thymiosicya* the ampullary notches are rarely clearly marked, and there is a marked difference between the radials and inter-radials in respect of the amount of anterior prolongation. Coupled with this we find that the anterior projections of the radials and inter-radials are clearly separated by a deep indentation (Pl. XXVI., figs. 6, 7, and 8).

Anal Teeth.

The presence of anal teeth is not a primitive character, although the anus of the primitive Holothurian was probably pentagonal.* I am inclined to think that the appearance of the anus in *Bohadschia* is more primitive than the conditions in *Halodeima* and *Thymiosicya*. In the latter sub-genera the anus is generally rounded, and the papillæ are not grouped around it in any definite manner. In *Bohadschia* the anus is surrounded by five groups of papillæ, which give the anus a

* That is to say, in the contracted condition. In *Bohadschia vitiensis* the pulsating anus is alternately rounded and pentagonal during the conditions of diastole and systole, respectively.

five-rayed appearance in the contracted condition. It is not difficult to understand how these groups of papillæ may be converted first into eminences very richly provided with spicules, and later into five calcareous masses. The presence of anal teeth in *Actinopyga* and *Argiodia* does not necessarily point to a close relationship between the two sub-genera, and it is possible that in the group under discussion, as in some of the Dendrochirotæ, these structures have little or no phyletic significance, and may have arisen independently in the two sub-genera.

Affinities of the five Sub-genera.

Taking these four characters and applying them to the five sub-genera, we find that with regard to the ambulacral appendages *Actinopyga* is the most primitive, since, with few exceptions, the pedicels are arranged in three rows on the trivium. In *Bohadschia,* which in other respects shows close affinities with *Actinopyga*, the pedicels are scattered over the trivium, with the notable exception of *Bohadschia gräffei.* The species of the sub-genus *Bohadschia* are described by many as having pedicels all over the body. If such be the case, this would strengthen the claim of *Bohadschia* to be considered the most primitive member of the genus. *Thymiosicya,* with its complete lack of true pedicels, may be regarded as the most highly specialized.

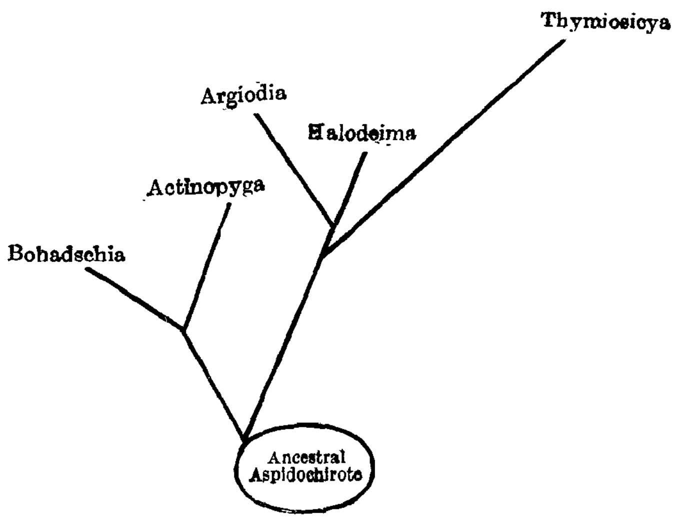
The evidence of the spicules points to *Actinopyga* and *Bohadschia* being the most primitive sub-genera, and also indicates their close relationship. The same conclusion is forced upon one by a comparative study of the calcareous ring.

I have already pointed out how the pentagonal anus of *Bohadschia* may be more primitive than the condition of things seen in the other sub-genera, and that the anal teeth of *Actinopyga* and *Argiodia* may be readily derived from the condition of things found in *Bohadschia.*

The weight of evidence goes to show that *Bohadschia* and *Actinopyga* are more closely related to each other than to the

other three sub-genera, and that *Bohadschia* is the more primitive form. The genera *Argiodia, Halodeima*, and *Thymiosicya* are united on the common ground of similarity of spicules and calcareous ring.

I show the relationship of the sub-genera in the following diagram :—



I give below the diagnoses of the genus and the sub-genera.

Genus HOLOTHURIA. Linn.

(= *Mülleria*, Jäger 1833 + *Holothuria*, Linn. 1758.)

Usually twenty peltate tentacles, exceptionally more or less. Ambulacral appendages, pedicels alone, papillæ alone, or with both. A single bundle of genital tubes on the left side of the dorsal mesentery. Calcareous ring without posterior prolongations or long retractor muscles. Cuvierian organs often present. Anal teeth sometimes present.

Sub-genus ACTINOPYGA.* Bronn.

(= *Actinopyga*, Bronn, 1860, partim; *Mülleria*, Jäger, 1833, partim.)

Generally twenty tentacles, but occasionally more. Ambulacral appendages, papillæ on the bivium and pedicels on the trivium, the former being scattered and the latter being usually arranged in three more or less distinct rows. Anal teeth present. Calcareous ring has well-marked bevelled ampullary notches, and the anterior border has no deep indentations between the radials and inter-radials. The radials extend almost as far forward as the inter-radials. Spicules small, generally taking the form of dichotomously branched rods or spinous rods, or both. Tables and "buttons" never present.

Eight species :—

Actinopyga agassizi (Selenka), *Actinopyga echinites* (Jäger), *Actinopyga formosa* (Selenka), *Actinopyga lecanora* (Jäger), *Actinopyga mauritiania* (Quoy & Gaimard), *Actinopyga miliaris* (Quoy & Gaimard), *Actinopyga obesa* (Selenka), *Actinopyga serratidens*, (Pearson).

Sub-genus BOHADSCHIA.† Jäger.

(= *Bohadschia*, Jäger, 1833; *Holothuria*, Linn. partim; *Sporadipus*, Brandt, 1835, partim.)

Twenty tentacles. Ambulacral appendages, pedicels, and papillæ. The trivium bears pedicels only, which are generally scattered, but which may be arranged in three rows. The bivium may bear either papillæ only, or papillæ mixed with pedicels (? or pedicels only). Anus surrounded by five groups of papillæ and in the contracted condition generally pentagonal in shape. Anal teeth absent. The calcareous ring closely

* This sub-genus is almost identical with Bronn's genus *Actinopyga*. I therefore retain this name.

† The sub-genus which I now establish for *H. marmorata* and the related forms is practically identical with Jäger's *Bohadschia*. I therefore propose re-establishing this name, which has long been discarded.

resembles that found in *Actinopyga*. Spicules in general similar to those of *Actinopyga*.

Five species :—

Bohadschia marmorata (Jäger), *Bohadschia argus* (Jäger), *Bohadschia vitiensis* (Semper), *Bohadschia paradoxa* (Selenka), *Bohadschia gräffei* (Semper).

Sub-genus ARGIODIA.* Sub-gen. nov.

(= *Mülleria*, Jager, 1833, partim; *Microthele*, Brandt, 1835, partim.)

Twenty tentacles. Ambulacral appendages, papillæ on the bivium and pedicels on the trivium; no arrangement into rows discernible. Anal teeth present. Calcareous ring having no well-marked ampullary notches. The anterior border deeply concave between the radials and inter-radials. Spicules well-developed and consist of tables and buttons.

Four species :—

Argiodia maculata (Selenka), *Argiodia parvula* (Selenka), *Argiodia excellens* (Ludwig), *Argiodia flavo-castanea* (Théel).

Sub-genus HALODEIMA.† Sub-gen. nov.

(= *Holothuria*, Linn. partim ; *Microthele*, Brandt, 1835, partim ; *Sporadipus*, Brandt, 1835, partim ; *Trepang*, Jäger, 1833, partim ; *Cystipus*, Haacke, 1880.)

Generally twenty tentacles, occasionally more or less. Ambulacral appendages, papillæ on the bivium and pedicels on the trivium. Generally no arrangement into rows discernible. Anal teeth absent. Calcareous ring having no ampullary notches. The anterior border deeply concave between the radials and inter-radials. Spicules rarely perforated, plates only, or tables only. Generally tables and perforated plates or buttons.

* ἀργιόδους = with white teeth.
† ἁλὸς = the sea; δεῖμα = monster.

This sub-genus contains a large number of species, of which *Halodeima atra* (Jäger) and *Halodeima monacaria* (Lesson) are representative.

Sub-genus THYMIOSICYA.* Sub-gen. nov.

(= *Holothuria*, Linn. partim ; *Fistularia*, Forskaal, 1775 ; *Trepang*, Jäger, 1833, partim.)

Twenty tentacles. Ambulacral appendages, papillæ only, which are often situated on wart-like eminences. Anal teeth absent. Calcareous ring similar to that of *Halodeima*. Spicules, tables, and buttons.

This sub-genus contains a large number of species, of which *Thymiosicya impatiens* (Forskaal) and *Thymiosicya spinifera* (Théel) may be said to be typical examples.

The following is a brief key to the sub-genera :—

A.—*Calcareous ring* with well-marked bevelled ampullary notches. The anterior border of the calcareous ring does not show the usual clear separation of radials from inter-radials. The inter-radials extend almost as far forward as the radials. *Spicules* small, and taking the form of dichotomously branched rods, or spinous rods, or both.

(*a*) With anal teeth.
.... *Actinopyga.*

(*b*) Without anal teeth.
.... *Bohadschia.*

B.—*Calcareous ring* without well-marked ampullary notches, and the anterior border is not bevelled. The anterior border of the calcareous ring deeply indented between the radials and inter-radials. The radials generally extending much further forward than the inter-radials. *Spicules* rarely consist of perforated plates, generally consist of tables and buttons.

* θυμιον = a wart ; σικυς = cucumber.

(*a*) With anal teeth.

.... *Argiodia.*

(*b*) Without anal teeth.

(*α*) Pedicels on trivium. Papillæ on bivium.

.... *Halodeima.*

(*β*) True pedicels absent. Papillæ scattered all over the body. Generally on eminences.

.... *Thymiosicya.*

EXPLANATION OF PLATE XXVI.

Fig. 1.—Simplest form of calcareous ring consisting of five radials and five inter-radials. *i.r.* = inter-radial ; *r.* = radial.

Fig. 2.—Simple form having an anterior notch in each radial, for the insertion of the radial muscle.

Fig. 3.—Simple form bearing ampullary notches : two complete notches and two half notches for each radial, and two half notches for each inter-radial. *a. n.* = ampullary notch.

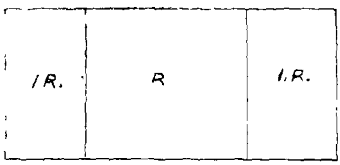
Fig. 4.—Calcareous ring of *Actinopyga miliaris* (Quoy & Gaimard).

Fig. 5.—Calcareous ring of *Bohadschia vitiensis* (Semper).

Fig. 6.—Calcareous ring of *Argiodia maculata* (Brandt).

Fig. 7.—Calcareous ring of *Thymiosicya hamata* (Pearson).

Fig. 8.—Calcareous ring of *Halodeima vagabunda* (Selenka).



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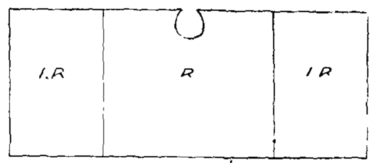

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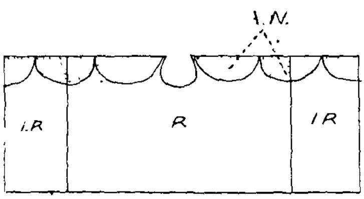

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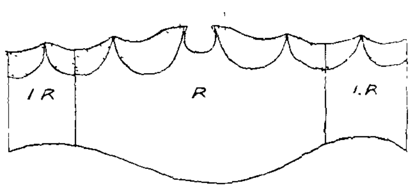

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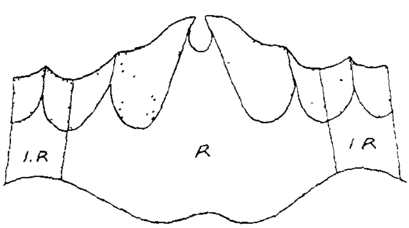

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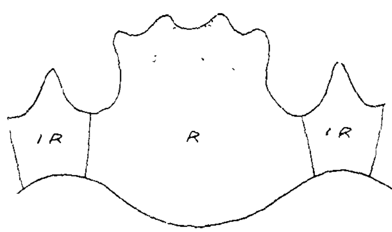

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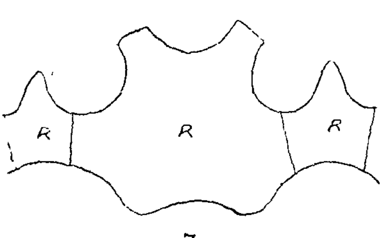

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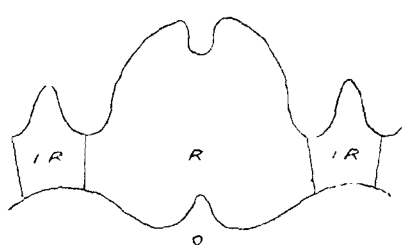

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J. P. del.

NOTES ON THE HOLOTHURIOIDEA OF THE INDIAN OCEAN.

By JOSEPH PEARSON.

(With three Plates.)

II.—THE SUB-GENERA ARGIODIA AND ACTINOPYGA.

IN a Paper published in this Journal* I have given reasons for combining the genera *Mülleria* and *Holothuria* under the latter name, and I divided the old genus *Mülleria* into two sub-genera, for which I proposed the names *Argiodia* and *Actinopyga*.

The material upon which the following notes are based is taken from the collections referred to in a previous Paper in this Journal.† Of the four known species of the sub-genus *Argiodia*, three have been recorded from the Indian Ocean, and all from the Indo-Pacific region. *Argiodia flavo-castanea* and *Argiodia parvula* have also been recorded from the Atlantic.

Of the eight species of *Actinopyga*, six have been recorded from the Indian Ocean, and seven from the Indo-Pacific region. Only one species, *Act. agassizi*, has not been found outside the Atlantic.

The species dealt with in the present Paper are as follows:—

Sub-genus ARGIODIA. Pearson.

Argiodia maculata (Brandt).
Argiodia flavo-castanea (Théel).
Argiodia parvula (Selenka).

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* *Pearson*: "Proposed Re-classification of the genera Mülleria and Holothuria."—*Spolia Zeylanica*, Vol. IX., Part XXXV., pp. 163–172.

† *Pearson*: "Notes on the Holothurioidea of the Indian Ocean, I.—The genus Holothuria."—*Spolia Zeylanica*, Vol. IX., Part XXXIV., pp. 49-101, Plates V.-XIV.

Sub-genus ACTINOPYGA. Bronn.

Actinopyga serratidens, Pearson.
Actinopyga miliaris (Quoy & Gaimard).
Actinopyga lecanora (Jäger).
Actinopyga echinites (Jäger).
Actinopyga mauritiana (Quoy & Gaimard).

Genus HOLOTHURIA.

Sub-genus **Argiodia.*** Pearson.

ARGIODIA MACULATA (Brandt).

(Pl. XXVII. and Pl. XXVIII., fig. 92.)

Holothuria maculata (sub-genus *Microthele*), Brandt 1835 (4).
Mülleria nobilis, Selenka 1867 (22); Semper 1868 (23); Théel 1886 (26).
Mülleria maculata, Ludwig 1881 (13), 1899 (17); Lampert 1885 (10); Sluiter 1901 (25).
Actinopyga maculata, Bedford 1899 (2).
Actinopyga nobilis, Fisher 1907 (5).
Mülleria hadra, Selenka 1867 (22); Lampert 1885 (10); Théel 1886 (26).

There are several specimens of this species at my disposal, chiefly from Ceylon, Seychelles, Red Sea, and Durban.

External Appearance.—This species is somewhat variable in colour. Generally it has an equal amount of black and light yellow, the two colours being arranged in irregular patches so as to give the animal a variegated appearance. Along each side of the body these blotches of light yellow and black alternate, and sometimes produce a striped appearance. Again, the animal may have a mottled appearance due to numerous small dark brown spots on a light yellow ground. The only specimen recorded from Ceylon was obtained by me during an inspection of the Pearl Banks in April, 1913, and it

* For definition see Pearson, *Spolia Zeylanica*, Vol. IX., Part XXXV., p. 170

has a uniform brown colour. Some specimens from Durban Museum have a similar colour.

The illustrations and descriptions of this species found in the literature of the subject do not emphasize sufficiently the appearance of the animal. This is undoubtedly due to the fact that most, if not all, previous descriptions have been made from preserved material. Undoubtedly the most characteristic feature of this species is the series of prominent lateral protuberances and the small dorsal wart-like outgrowths, and in all the preserved material at my disposal I have been able to make these out only with the greatest difficulty. In some specimens they appear to be entirely absent. Whether there is any considerable amount of variation in this respect I cannot say. In the only living specimen I have been able to examine the lateral prominences are well developed, as shown in Pl. XXVI. After this particular specimen was preserved the elevations were only imperfectly seen, and the small dorsal tubercles disappeared altogether *

A living specimen taken on the Ceylon pearl banks measured 350 mm. long and 150 mm. in greatest breadth. There were five large protuberances on each side of the body at the junction of the bivium and trivium. These elevations stood out about 16 mm. beyond the general contour of the body. On each radius of the bivium was a row of smaller tubercles, about a dozen in each row. The ambulacral appendages consisted of small papillæ irregularly scattered on the bivium and larger and more numerous pedicels on the trivium. In some specimens, obviously due to contraction, there is a clear distinction between the trivium and the rest of the body, as the ventral surface forms a distinct sole. The colour during life was uniform auburn-brown on the bivium and a slightly lighter colour below.

* Since writing the above I have obtained another specimen of this species from the Ceylon pearl banks. It had the typical yellow and black blotches referred to above, and the lateral projections were not well marked. It is probable, therefore, that the well-defined projections shown in Pl. XXVII. are not typical of the species. The figure is retained as it was drawn from life, and it may be regarded as an unusual example of the species, both as regards colour and the size of the lateral projections.

This species has from eighteen to twenty tentacles and five small anal teeth. Opposite each tooth is a group of papillæ.

The ambulacral appendages all have well-developed sucking discs, but it is highly probable that the ventral appendages alone are used in locomotion.

Internal Structure.—The calcareous ring is well developed. The radial pieces have three anterior indentations alternating with four blunt processes. The inter-radials possess a single anterior tooth. The posterior part of each radial piece is separated from the anterior part by a well-defined curved suture.

There is generally one stone canal attached to the right side of the dorsal mesentery and one large Polian vesicle.

Spicules.—The calcareous deposits consist of tables and peculiar hollow fenestrated bodies. The tables are comparatively scarce, and are masked to a great extent by the large numbers of fenestrated bodies that lie in the deeper layers of the perisome. The tables are 66 μ in diameter and 50 μ high. The hollow spicules are 80 μ long.

Remarks.—According to Selenka the only difference between this species and *Argiodia hadra* (Selenka) is in the nature of the calcareous ring. In the latter form the antero-posterior axis of the radials and inter-radials is much longer in proportion than in *Argiodia maculata.* I am inclined to think that *Argiodia hadra,* apparently described by Selenka from a single specimen, should be included in the species *maculata.*

General Distribution.—Indo-Pacific region.

ARGIODIA FLAVO-CASTANEA (Théel).

(Pl. XXVIII., fig. 3.)

Mülleria flavo-castanea, Théel 1886 (26).

One specimen from Munich, found in the Red Sea.

External Characters.—The specimen under examination is much larger than Théel's specimen and is different in colour, but otherwise agrees with Théel's description. It is 280 mm.

long in the contracted condition, and is light yellow in colour. The pedicels on the trivium are crowded together and form a kind of sole, as described by Théel. The dorsal papillæ are not so numerous or so large. There are slight elevations at each side of the body, which may be due to the contraction of the specimen, or they may be similar projections to those described in *Argiodia maculata.* There are twenty tentacles.

Internal Structure.—The calcareous ring is similar to that of *Argiodia maculata.* There is one large Polian vesicle, but no stone canal can be seen. Théel records the presence of a single stone canal. There are no Cuvierian organs present, although they were present in Théel's type specimen.

Spicules.—These consist of tables and knobbed buttons. The tables are 55 μ in diameter and about the same height. The buttons, which are about 80 μ long, have four or five pairs of holes, and in the centre bear three or four knobs.

General Distribution.—Madeira, Red Sea. A rare form, with a curious distribution.

Remarks.—Only in one respect does this species differ from *A. maculata,* and that is in the nature of the buttons. Apart from this character the two species appear to be identical. I cannot admit with Théel and Bedford the possibility of this species being identical with *A. parvula,* as the buttons are different, and the calcareous rings of the two species are dissimilar.

Argiodia parvula (Selenka).

(Pl. XXVIII., fig. 4.)

Mülleria parvula, Selenka 1867 (22) ; Lampert 1885 (10) ; Théel 1886 (26).

Actinopyga parvula, Bedford 1898 (1) ; Fisher 1907 (5).

There are several specimens from Prof. Gardiner's Maldive collection and one specimen from the Dublin Museum obtained from the Seychelles.

External Characters.—This appears to be a very small species, and I cannot find any record of a specimen over 50 mm. in length. The largest specimen I have examined is only

40 mm., and several of them are only 25 mm. Thus, this species is very different from other species of the genus, the members of which are usually characterized by a large size. The small size of the specimens makes it difficult to determine the characters. The colour is generally dark brown, but the Seychelles specimen is light yellow. The ventral pedicels are crowded and are of comparatively large size. The dorsal papillæ are apparently much smaller and less numerous. There are twenty tentacles, and the anus is surrounded by five minute teeth.

Internal Structure.—The calcareous ring agrees with Fisher's figure more than with Selenka's. The two anterior lateral notches of the radial pieces figured by Selenka are not present in any of the specimens I have examined. The small size of the specimens has not permitted the stone canal and Polian vesicles to be clearly made out. Selenka describes one of each, and Fisher makes out two Polian vesicles and one stone canal. Cuvierian organs are present, according to Fisher.

Spicules.—These consist of tables and smooth buttons, and closely resemble the deposits of *Halodeima difficilis*, and probably explain why Haacke (according to Ludwig) mistook some specimens of the latter species for the species under discussion. The tables are pierced with about eight peripheral holes, which alternate with an equal number of smaller holes. The base is 70 μ in diameter, and the tower, which bears a spinous top, is about 55 μ in height. The buttons are oval and smooth, and are irregularly pierced by about three pairs of holes. These buttons are about 85 μ in length.

Remarks.—This species is distinguished from *Argiodia flavo-castanea* by (*a*) its size ; (*b*) the shape of the calcareous ring, although this character is apparently variable ; and (*c*) the nature of the buttons. So far as our small knowledge of the two forms goes, there is no reason to believe they are identical, as Théel and Bedford have suggested.

General Distribution.—The distribution of this species is interesting, and includes Florida, Seychelles, Maldives, Hawaii, and Funafuti.

Sub-genus **Actinopyga.*** Bronn.

ACTINOPYGA SERRATIDENS. Pearson.

(Pl. XXIX., fig. 5.)

Actinopyga serratidens, Pearson 1903 (18).

This species was named and described by the present writer in 1903 from a single specimen obtained by Professor Herdman from Galle, Ceylon. Since then it has not been recorded. Amongst the Holothurians collected by Mr. Crossland at Suakim in the Red Sea, and sent to me by Prof. Stanley Gardiner, are several specimens of this species. During a two months' inspection cruise on the Ceylon pearl banks early in 1913, I found this species extraordinarily abundant. With the exception of *Halodeima atra*, which appears to be the predominant Holothurian along the Ceylon coast, and *Bohadschia marmorata* and *Thymiosicya scabra*, which are abundant though limited in their distribution, I consider the above species the commonest form in the littoral waters of Ceylon. It is also one of the largest Holothurians I have seen, and frequently attains a size of 400 mm.

External Appearance.—Without exception the Ceylon specimens are uniformly black, with a faint suggestion of dark brown. All the Red Sea specimens, except one, on the other hand, are black above and yellowish-white below, and at first sight resemble *Actinopyga mauritiana*. The single exception is similar to the Ceylon specimens in colour. Out of more than one hundred specimens from Ceylon waters, all from the pearl banks, I have not seen one which has any trace of light colour about it, with the exception of the pedicels, which are sometimes white. The ambulacral appendages consist of numerous pedicels evenly distributed over the trivium, and small papillæ scattered over the bivium and less abundant than the pedicels. There are twenty dark brown tentacles. The anal teeth are large and yellow and irregular in shape, producing the serrated appearance referred to in my original

* For definition see Pearson, *Spolia Zeylanica*, Vol. IX., Part XXXV., p. 169.

description of the species. This is not the only species of Mülleria that has irregularly formed teeth. I have found that in most species, particularly in *A. echinites*, individuals may occasionally have serrated teeth. The only specimen of *A. agassizi* that I have examined has teeth very similar to those of *A. serratidens*, but I cannot say whether this is a regular character. In *A. serratidens* all the specimens I have had occasion to examine have irregular teeth.

The ventral pedicels are not arranged in series, but are evenly scattered over the trivium. Frequently they are white. The papillæ are invariably black, and are scattered over the bivium without definite arrangement. They are smaller and less numerous than the pedicels. There are twenty dark brown tentacles.

Internal Structure.—The calcareous ring is similar to that in most species of the sub-genus. There is one Polian vesicle. In the type specimen described by me in 1903 there were eight stone canals. In most of the Ceylon specimens recently examined, the stone canal was single and was attached to the right side of the dorsal mesentery.

In a few cases I have observed from sixty to a hundred small bodies evenly distributed on both sides of the dorsal mesentery on a level with the Polian vesicle. These bodies are extremely small, and the short stalk ends in a white globular head ·6 mm. in diameter. These problematic bodies are similar in position and appearance to those described by Selenka (22) in *Actinopyga mauritiana* (*Mülleria varians*).

No other points in the internal structure call for special comment, the respiratory trees and the Cuvierian organs being typical.

Spicules.—The spicules in the Ceylon specimens are similar to those described by me from the type species. Usually, owing to the dark pigment, the spicules are hard to see. In the specimens from the Red Sea the spicules are much more abundant, particularly in the ventral perisome, where, owing to the absence of pigment and to their being very closely packed, their presence is very readily detected.

General Distribution.—Ceylon, Red Sea, Maldives.

ACTINOPYGA MILIARIS (Quoy & Gaimard).

(Pl. XXIX., fig. 6.)

Holothuria miliaris, Quoy & Gaimard 1833.

Holothuria lineolata, Quoy & Gaimard 1833 (21).

Mülleria miliaris, Brandt 1835 (4); Selenka 1867 (22); Ludwig 1882 (14), 1887 (15), 1888 (16), 1899 (17); Lampert 1885 (10); Théel 1886 (26); Bell 1887 (3); Sluiter 1901 (25); Koehler & Vaney 1908 (9); Pearson 1910 (19).

Mülleria lineolata, Brandt 1835 (4).

Mülleria plebeja, Selenka 1867 (22).

External Characters.—This species attains a size of about 200 mm. It is generally coloured a uniform dark brown. Rarely is the ventral surface lighter than the dorsal. There are twenty tentacles.

Internal Structure.—Internally there appears to be no difference from the arrangement seen in *Actinopyga lecanora.* In one specimen examined there were two well-developed Polian vesicles and one stone canal. The calcareous ring is of the usual type seen in this genus.

Spicules.—These consist of numerous minute "rosettes," which are dichotomously branched, and which are about 32 μ in length.

Remarks.—Selenka examined Quoy & Gaimard's original specimens in Paris, and we have to accept his assurance that *Holothuria miliaris*, Q. & G., *Holothuria lineolata*, Q. & G., and *Mülleria plebeja*, Selenka, are all identical. It is fortunate that Quoy & Gaimard's specimens were preserved, since the original descriptions were insufficient for the purposes of identification. This to some degree may be said to apply to Selenka's description of *Mülleria plebeja.* Why Selenka and subsequent writers did not retain the name *lineolata* is not quite clear, since it appears before *miliaris* in the original description and therefore takes precedence. The name

lineolata, though correct, has not been used since 1835, and, therefore, on the grounds of convenience, I propose retaining the name *miliaris*. With reference to the relationship between *Actinopyga miliaris* and *Actinopyga lecanora,* see my remarks under the latter species.

General Distribution.—Indian Ocean, East Indies.

ACTINOPYGA LECANORA (Jäger).

(Pl. XXIX., fig. 9.)

Mülleria lecanora, Jäger 1833 (7) ; Selenka 1867 (22) ; Semper 1868 (23) ; Ludwig 1881 (13), 1882 (14), 1887 (15) ; Lampert 1885 (10) ; Théel 1886 (26) ; Sluiter 1887 (24), 1901 (25) ; Vaney 1905 (27) ; Koehler & Vaney 1908 (9) ; Pearson 1910 (19).

Holothuria dubia (sub-genus *Microthele*), Brandt 1835 (4).

Actinopyga lecanora, Bedford 1899 (2).

External Characters.—This species attains a length of upwards of 200 mm. It is chocolate-brown above with light yellow mottlings and is light yellow below. There is a light area around the anus. The dorsal papillæ are scattered, and are smaller than the ventral pedicels. The latter show a distinct arrangement into three broad rows, although there are pedicels scattered on the interambulacra. There are twenty dark tentacles.

Internal Structure.—The calcareous ring is similar in general appearance to the common type of the sub-genus. There is a single Polian vesicle and a single stone canal on the right side of the dorsal mesentery.

Spicules.—These are similar to the deposits of *Actinopyga miliaris* in both shape and size, but differ in being arranged in groups.

Remarks.—There appears to be very little difference between this species and *Actinopyga miliaris.* The only two points of difference are in the colour and the deposits. *A. miliaris* has a uniformly-coloured body, generally a dark

brown. *A. lecanora*, on the other hand, is lighter on the trivium and has a light patch around the anus. The spicules of both forms are exactly alike, but in *A. lecanora* they are stated by most writers to be arranged in little groups. I have not had access to a large series of these two species, so that I am not in a position to give an opinion on the value of these two distinguishing characters. Perhaps the most striking is the light circular area around the anus, and this would appear to be constant. In a Japanese specimen of *A. lecanora* I have been unable to satisfy myself that there is any distinct arrangement of the spicules into groups. Any investigator who has the opportunity of examining a large series of these two forms would do well to go into the question of colour and spicular differences.

General Distribution.—Indo-Pacific.

ACTINOPYGA ECHINITES (Jäger).

(Pl. XXIX., fig. 7.)

Mülleria echinites, Jäger 1833 (7); Selenka 1867 (22); Semper 1868 (23); Ludwig 1882 (14), 1887 (15), 1899 (17); Lampert 1885 (10), 1895 (12); Théel 1886 (26); Whitelegge 1897 (28), 1903 (29); Sluiter 1901 (25); Pearson 1910 (20).
Actinopyga echinites, Bedford 1898 (1).

A fairly common form in the Indo-Pacific region. It is well represented in most of the collections at my disposal.

External Characters.—A large robust form frequently attaining a size of over 250 mm., though generally less than this in preserved specimens. The body is much stouter in the middle than in most Holothurians, and the greatest width may be nearly half the total length. The body is slightly curved and becomes narrower at each end. The mouth is ventral and is surrounded by a distinct rim formed of papillæ. The anus is slightly dorsal and is surrounded by five teeth, which often have an irregular surface. There are twenty dark brown

tentacles. In the living specimen the bivium is generally slightly wrinkled, and these grooves are much more accentuated in spirit specimens.

The ambulacral appendages are pedicels on the trivium and papillæ on the bivium. The pedicels are arranged in three broad rows with a few on the interambulacra.

The papillæ on the bivium are fairly large and are evenly scattered. Théel's statement that there are true pedicels on the bivium does not appear to be correct, since in the living specimen none of the dorsal appendages have the suctorial qualities of true pedicels. In no case have I found that the dorsal appendages have the qualities of true pedicels, although they may have a sucking disc strengthened by a perforated plate.

Internal Structure.—The calcareous ring is similar to that of *Act. miliaris*, but is slightly variable. Usually there is a single large stone canal attached to the right side of the dorsal mesentery, and there is one large Polian vesicle.

Spicules.—These consist of richly branched rods having a length of 80 μ and smaller dichotomously branched rosettes similar to those of *Act. miliaris*, except that the branching is richer. These are about 30 μ in length. There are also larger irregular rods in the pedicels and papillæ having a length of 130 μ.

Remarks.—This species is undoubtedly related to *Act. miliaris*, but the deposits are always larger and more richly branched. A specimen from Prof. Stanley Gardiner's collection has given me some trouble owing to the nature of the spicules. The specimen is full-sized and is light yellow in colour, and has all the characters associated with *Act. echinites*, except the anal teeth, which are large and serrated like those of *Act. serratidens*. The spicules are abundant, but different from those of any known species. I have come to the conclusion that it is a specimen of *Act. echinites* in which the spicules have been partly dissolved, probably owing to the action of formalin.

General Distribution.—Indo-Pacific.

ACTINOPYGA MAURITIANA (Quoy & Gaimard).

(Pl. XXIX., fig. 8.)

Holothuria mauritiana, Quoy & Gaimard 1833 (21).
Mülleria mauritiana, Selenka 1868 ; Ludwig 1882 (14), 1887 (15), 1888 (16), 1899 (17) ; Lampert 1885 (10), 1889 (11) ; Théel 1886 (26) ; Sluiter 1887 (24), 1901 (25) ; Koehler & Vaney 1908 (9) ; Pearson 1910 (29).
Mülleria varians, Selenka 1867 (22).
Actinopyga mauritiana, Bell 1887 (3) ; Bedford 1898 (1), 1899 (2) ; Pearson 1903 (18) ; Fisher 1907 (5).

This species is represented in most of the collections under examination. It is universally distributed throughout the Indo-Pacific, and is perhaps the commonest species of *Actinopyga.*

External Appearance.—This species is subject to much variation in colour. The commonest type is coloured chocolate-brown on the bivium and yellowish-white on the trivium, the two being distinctly separated, so that the white trivium forms a kind of sole. Sometimes the papillæ in the bivium are surrounded by yellowish-white rings. Occasionally these rings coalesce to form irregular patches. In several specimens I have examined there is no clear separation of colour of the lighter trivium from the darker bivium, the transition from the one to the other being gradual. In a few instances there is very little brown on the bivium owing to the yellow rings around the papillæ being extremely numerous. In fact, every stage of colour is represented between the two extremes, on the one hand the form in which the limits of the brown bivium and yellowish-white trivium are very clearly defined, and on the other the form in which brown is mottled on a yellow ground, both on the dorsal and ventral surfaces. There are usually twenty-five tentacles present. The five anal teeth are smooth and are of medium size. This species grows to a length of over 400 mm.

The ambulacral appendages consist of papillæ on the bivium and true pedicels on the trivium. The latter are more closely

arranged than the former and are evenly scattered over the ventral surface without showing, as a rule, any disposition into rows. In a young specimen about 100 mm. long, however, I have discerned three rows of tube feet, each row being about eight pedicels wide.

Internal Structure.—The calcareous ring differs but little from the usual type seen in this genus. The radials have three anterior concavities, the middle one being shallower than the two lateral ones. The inter-radial piece has a single anterior tooth.

This species has a variable number of stone canals. In various specimens I have counted from six to twenty, equally disposed on both sides of the dorsal mesentery. The stone canals generally have a twisted stalk and a swollen end, and sometimes they are branched. Selenka (22) in his account mentions the presence of a " knopfförmig " stone canal and then proceeds to mention the presence of " eine anzahl von kleinen mit elliptischen körpern prall gefüllten Bläschen." Whether these bodies are really stone canals as their position in his figure would suggest, and whether they are similar to the bodies described by me from *Actinopyga serratidens*, I cannot say. The number of Polian vesicles is also variable. In the specimen with twenty stone canals there were three long narrow Polian vesicles 30 mm. long in the contracted condition. Frequently only one vesicle is present.

Spicules.—The deposits are very characteristic, and are of two distinct kinds. Those on the bivium are either small dichotomously branching " rosettes " 50 μ long, or longer spinous rods 80 μ in length. The deposits of the ventral surface consist entirely of oval grains 22 μ in diameter.

General Remarks.—There appears to be some reason for Théel's suggestion that *Actinopyga agassizi* is probably a variety of the above species. The two, however, differ with regard to the spicules of the bivium. In *A. agassizi* they consist of small X-shaped bodies, which are not so numerous as the characteristic spiny rods of *A. mauritiana*. The calcareous rings are similar, and in both cases there are about twenty-five tentacles. In a specimen of *A. agassizi* examined by me, the body had a uniform colour of chocolate-brown with

one or two small yellow patches on the dorsal surface. The pedicels were light yellow in colour and were scattered all over the trivium, though much more numerous in the radii. So far as I can ascertain *A. mauritiana* is solely confined to the Indo-Pacific, while *A. agassizi* has been found in the Atlantic, but never in the Pacific. There are, however, many instances of Pacific forms being found in the Caribbean Sea,. *Argiodia parvula* being a case in point. *Actinopyga mauritiana* is very constant with regard to its spicules, and I have never examined a specimen in which the dorsal spicules resembled those of *A. agassizi* figured by Selenka. The single specimen of *A. agassizi* examined by me agrees with Selenka's description in this respect. There would appear to be a constant difference in the spicules of the two forms. It will be more convenient and reasonable to regard them as distinct, though undoubtedly closely related.

General Distribution.—Indo-Pacific.

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Expla[illegible]ion of Pla[illegible].

Pl[illegible] XXVII.

Argiodia maculata (Brandt).—View from th[illegible] dorsal surface. (Dra[illegible]om life.)

Plate X[illegible]VIII.

Argiodia maculata (B[illegible]).

Fig. 2*a*.—View of table from below. × [illegible]
Fig. 2*b*.—Hollow fenestrated button. × 475.
Fig. 2*c*.—Side view of table. × 650.
Fig. 2*d*.—Calcareous ring. × 2½.

Argiodia [illegible]ea (Théel).

Fig. 3*a*.—Knobbed butto[illegible]. × [illegible]
Fig. 3*b*.—View of table from below. × [illegible]0.
Fig. 3*c*.—Side view of table. × 550.
Fig. 3*d*.—Calcareous ring. × 1¼.

Argiodia [illegible] (Selenka).

Fig. 4*a*.—View of table from below. × 570.
Fig. 4*b*.—Side view of table. × 570.
Fig. 4*c*.—Button. × 520.
Fi[illegible]d.—Calcareous ring. × 4.

Plate XXIX.

[illegible], Pearson.

[illegible]ous ring. × 2½.
[illegible]shaped" spicules. × 750.
[illegible]st type of spicules. × 750.

[illegible] & Gaimard).

[illegible] 6*b*. } [illegible]
Fig. 6*c*.—[illegible] × 2[illegible]

Actin[illegible]

Fig. [illegible]
Fig. 7[illegible]
Fig. [illegible] integument. × 475.
Fig. [illegible] × 385.

Actinopyg[illegible] [illegible]ard).

Fig. 8*a*.—Spi[illegible]ument. × 650.
Fig. 8*b*.—[illegible] × 680.
Fig. 8*c*.—[illegible]m dorsal i[illegible]ent. × 570.
Fig. 8*d*.—" G[illegible]n the vent[illegible]gument. × 500.
Fig. 8*e*.—Calc[illegible] × 1¼.

Actinopyga lecanora [illegible]).

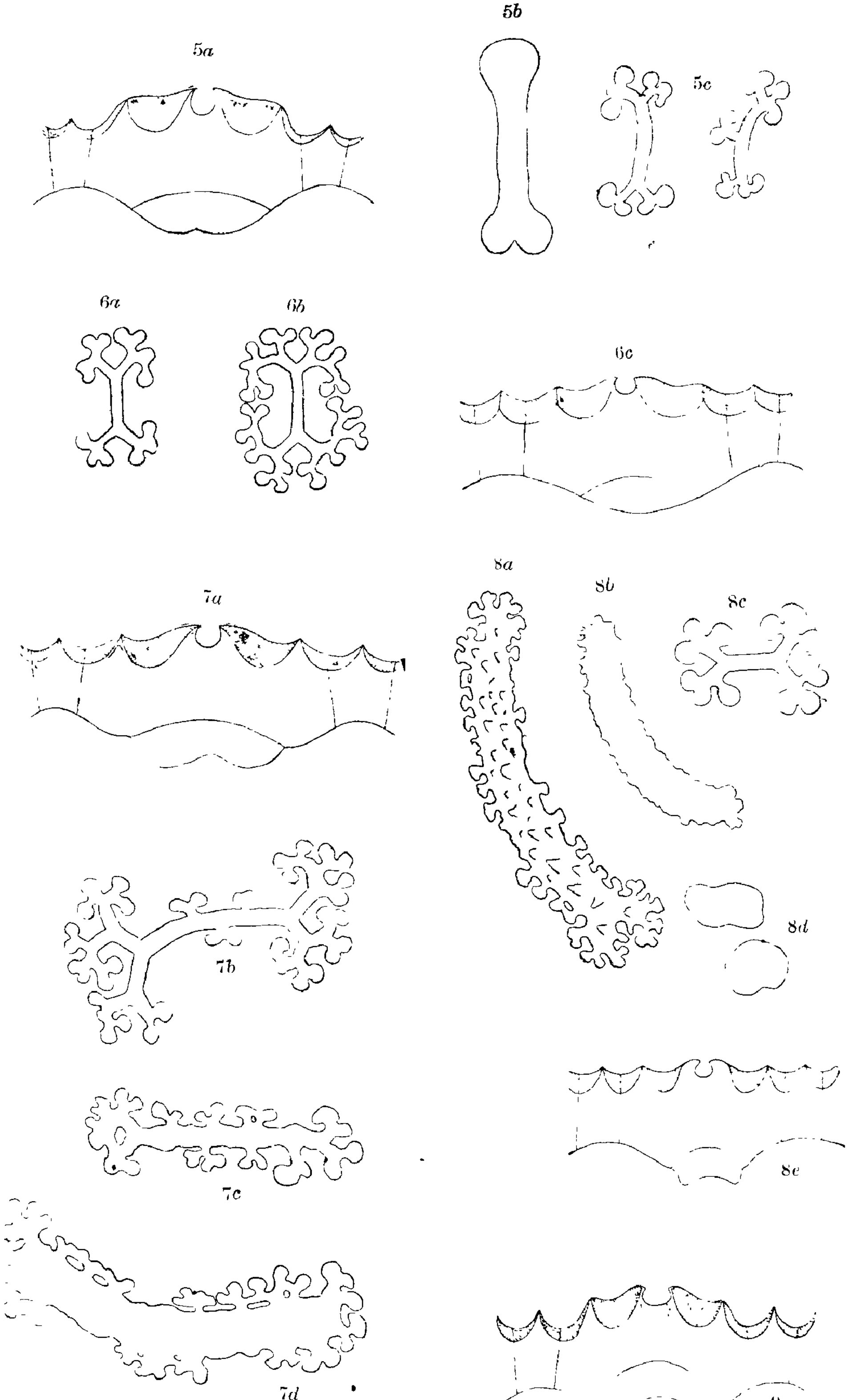
Fig. 9.—Calcareous [illegible]g. × 2½.

G. H. del.

ARGIODIA MACULATA.

P. del.

2.—Argiodia maculata. Fig. 3.—Argiodia flavo-castanea. Fig. 4.—Argiodia parvul



I. P. del.

FIG. 5.—ACTINOPYGA SERRATIDENS
FIG. 6.—ACTINOPYGA MILIARIS.
FIG. 7.—ACTINOPYGA ECHINITES.
FIG. 8.—ACTINOPYGA MAURITIANA
FIG. 9.—ACTINOPYGA LECANORA.

NOTES ON THE SURFACE COPEPODA OF THE GULF OF MANNAR.

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(With five Plates and one Map.)

THE collections on which the following notes are based are two in number. The first of these is a very extensive one from the Ceylon pearl banks and neighbouring waters. This collection was made by Mr. T. Southwell during the years 1906–09, when he was Scientific Adviser to the Ceylon Pearl Fishery Syndicate, and comprises 326 samples ; at the time when the Syndicate ceased its operations, this collection was handed over to Dr. J. Pearson, the Director of the Colombo Museum, and I have to thank him for entrusting it to me for examination. The second collection was made by Mr. S. W. Kemp, of the Indian Museum, during the month of February, 1913, at Paumben and Kilakarai on the south coast of India. The collections proved to be exceedingly rich, containing in all 87 species and varieties, of which five are new to science, namely, *Acrocalanus similis*, *Scolecithricella pearsoni*, *Centropages trispinosus*, *Acartia southwelli*, *Acartiella kempi*, gen. nov.; and in addition I am able to record the occurrence of the following hitherto unknown forms :—*Eucalanus mucronatus*, ♂ ; *Labidocera pavo*, ♂ ; *Acartia amboinensis*, ♂ ; *Tortanus forcipatus*, ♂.

In the accompanying table I have given a complete list of the various species and varieties, and have indicated by + the various localities in which they were present. For the most part the species are widely distributed, but it is of interest to note that the species of the genera *Euchæta*, *Scolecithrix*, *Scolecithricella*, and *Candacia* appear to be very largely confined to the region of the pearl banks lying to the west of Karativu island, between it and the overfalls, including

Dutch Moderagam, Karativu, and Alanturai paars, all of which localities proved to be exceedingly rich as regards the Copepod fauna.

The positions of the various localities in which collections were made are shown on the chart, but in the case of many of the paars they are approximate only.

Family, CALANIDÆ.

Genus **Calanus,** Leach.

CALANUS MINOR (Claus.).

* *Calanus minor,* Giesbrecht, 1888, p. 331.
——————— Giesbrecht, 1891, p. 282.
——————— Cleve, 1901, p. 5.
——————— A. Scott, 1902, p. 422.
——————— Thompson & Scott, 1903, p. 241.
——————— Wolfenden, 1905, p. 995.
? *Calanus caroli* (♀), Wolfenden, 1905, p. 994.
Calanus minor, Cleve, 1905, p. 186.
——————— A. Scott, 1909, p. 7.
——————— Sewell, 1912, p. 354.
Undinula caroli (♀), Sewell, 1912, p. 356.
Calanus minor, Pesta, 1913, p. 30.

This species is comparatively rare on the pearl banks, and is absent altogether in the majority of tow-nettings. Most of the specimens obtained were females. Wolfenden (1905) obtained a female calanid, of which he gives neither a full description nor any figures, from the Maldive and Laccadive Archipelagoes: he believed this form to be the hitherto-unknown female of *Undinula* (*Calanus*) *caroli,* Giesbrecht. I obtained what appeared to be similar examples from the Burma coast, but a subsequent examination showed that they were in reality examples of *Calanus minor,* and, as I have pointed out below (p. 199), there seems to be some reason for believing that *Undinula caroli* is merely a variety of *Undinula darwini,* Giesbrecht (♂).

* In the majority of cases the list of references only includes those that refer to the occurrence of the species in Indian waters.

CALANUS TENUICORNIS, Dana.

Calanus tenuicornis, Cleve, 1904, p. 186.
——————— A. Scott, 1909, p. 8.

This species was represented by a single female taken near Karativu Paar. Its occurrence is of some interest, as it is the first occasion on which it has been recorded from Indian coastal waters.

Genus **Canthocalanus,** A. Scott.

CANTHOCALANUS PAUPER (Giesbrecht).

Calanus pauper, Thompson, 1899, p. 275.
——————— Cleve, 1901, p. 5.
——————— A. Scott, 1902, p. 400.
——————— Cleve, 1903, p. 357.
——————— Thompson & Scott, 1903, p. 241.
——————— Wolfenden, 1905, p. 995.
Canthocalanus pauper, A. Scott, 1909, p. 9.
Calanus pauper, Pesta, 1912, p. 43.
Canthocalanus pauper, Sewell, 1912, pp. 315 and 355.
Calanus pauper, Pesta, 1913, p. 30.

CANTHOCALANUS PAUPER, var. PLUMULOSUS, Wolfenden.

Canthocalanus pauper, var. *plumulosus*, Sewell, 1912, p. 355.

This species was universally distributed over the pearl banks and neighbouring waters, occurring at times in large numbers. Wolfenden (*loc. cit.*, p. 994, 1905) has called attention to a curious modification of the furcal setæ which is occasionally met with in *Undinula vulgaris*, *Paracalanus aculeatus*, *Calocalanus pavo*, and *Euchirella bella* var. *indica*. This modification consists of " a more or less dichotomous

branching, repeated in the sub-branches, the whole forming a sort of brush," and he has proposed that examples showing this character should be considered as a variety under the name "*plumulosus.*" I have previously (*loc. cit.*, pp. 355, 357, and 359) recorded a similar modification in *Canthocalanus pauper*, *Undinula caroli*, and *Acrocalanus longicornis.*

Numerous specimens, both of the above species and of *Undinula vulgaris*, showed this peculiarity, and a study of these examples has caused me to alter my opinion. I am inclined to regard this branching of the setæ merely as an abnormality and not a true variety. In the tables below I have given the results obtained from an examination of the furcal setæ of a series of individuals of these two species, in which this peculiarity was present to a greater or less degree; in all cases the seta showing the modification is indicated by +.

Canthocalanus pauper.

No. and Sex.	Left Furca.					Right Furca.					
	5	4	3	2	1	1	2	3	4	5	
1 ♂	.	.	.	+	.	.	+	.	.	.	Average number of setæ affected in ♂, 2·3.
2 ♂	.	.	.	+	.	.	.	.	+	.	
3 ♂	.	.	.	.	.	.	+	+	.	.	
4 ♂	.	.	.	+	.	.	.	.	.	.	
5 ♂	.	+	+	+	.	.	+	+	.	.	
6 ♂	.	+	+	+	.	.	+	+	.	.	
7 ♂	.	.	.	.	.	+	.	.	.	.	
8 ♂	.	.	.	.	.	.	+	+	.	.	
9 ♂	.	.	.	+	.	.	.	.	.	.	
10 ♀	.	+	+	+	.	+	+	+	.	.	Average number of setæ affected in ♀, 5·1.
11 ♀	.	+	+	+	.	+	+	+	.	.	
12 ♀	.	+	+	+	+	+	.	+	.	.	
13 ♀	.	+	+	+	.	.	+	+	+	+	
14 ♀	.	.	+	+	+	+	+	+	.	.	
15 ♀	.	.	.	.	.	.	+	.	.	.	
16 ♀	.	+	+	+	.	.	+	+	.	.	
17 ♀	.	+	+	+	.	.	+	+	+	.	
18 ♀	.	+	+	+	+	.	+	+	.	.	
19 ♀	.	+	+	+	.	.	+	+	.	.	
20 ♀	.	.	+	+	.	.	.	.	.	.	
Number of times each seta is affected	0	10	12	16	3	5	14	13	3	1	

Undinula vulgaris.

No. and Sex.		Left Furca. 5	4	3	2	1	Right Furca. 1	2	3	4	5	
1	♂	.	.	.	.	.	.	.	.	+	.	Average number of setæ affected, 3·7.
2	♂	.	.	.	.	+	.	.	.	.	.	
3	♂	.	.	.	+	+	.	.	.	.	.	
4	♂	.	.	+	+	.	+	+	.	.	.	
5	♂	.	+	+	+	+	+	+	+	+	.	
6	♂	.	.	.	+	+	+	+	+	+	.	
7	♀	+	+	+	+	.	.	+	+	.	.	With spermatophores, average number of setæ affected, 4·3.
8	♀	.	+	.	.	.	.	.	.	.	.	
9	♀	.	.	.	+	+	.	.	+	.	.	
10	♀	.	+	.+	+	+	+	+	+	+	.	
11	♀	.	.	.	+	+	+	.	+	.	.	
12	♀	.	+	+	+	+	+	+	.	.	.	
13	♀	.	.	+	+	+	+	+	+	.	.	
14	♀	.	.	+	+	+	+	+	.	.	.	
15	♀	.	.	.	+	.	.	.	.	.	.	
16	♀	.	+	.	.	.	.	.	.	.	.	
17	♀	.	.	+	+	.	.	+	+	+	.	
18	♀	.	+	+	+	+	+	+	+	.	.	
19	♀	.	.	+	.	.	..	.	.	.	.	
20	♀	.	.	+	.	.	.	.	.	.	.	
21	♀	.	.	.	.	+	+	+	+	+	.	
22	♀	+	.	.	.	+	.	+	.	.	.	
23	♀	.	.	.	.	.	.	+	.	+	.	
24	♀	+	+	+	+	+	+	+	.	.	.	
25	♀	.	.	.	.	.	.	+	+	+	.	
26	♀	.	+	+	+	+	.	.	.	.	.	
27	♀	+	+	+	+	.	+	+	+	+	.	
28	♀	.	+	+	+	+	+	+	+	+	.	
29	♀	.	.	.	.	.	.	+	.	.	.	Without spermatophores, average number of setæ affected, 2·2
30	♀	.	.	.	.	+	+	+	+	.	.	
31	♀	.	+	.	.	+	+	.	.	.	.	
32	♀	.	.	.	.	.	.	+		.	.	
Number of times each seta is affected		4	12	15	18	18	15	20	14	10	.	

From the above it is evident that there is little or no regularity in the disposition of the plumose setæ in any particular individual, in some cases only a single hair showing this change, in others all ten doing so; it is quite exceptional to find any attempt at symmetry in the arrangement. It will be noticed that in the number of individuals affected, the proportion of females is larger than that of males, but a

difference such as this might easily be accounted for by the greater preponderance of females in the catch.

With regard to the total number of hairs affected and their relative position, it is quite clear that on the whole far more setæ are abnormal in the female than in the male, and, further, the setæ most frequently affected are those that possess the greatest length, *i.e.*, numbers 2, 3, and 4.

I have on one occasion found a similar " plumose " seta arising from the tip of a damaged antenna in an example of *Acrocalanus longicornis*. In this case the antenna had obviously been damaged on some previous occasion, the terminal segments being broken off; subsequently the stump had healed, and from the scar this seta had arisen.

I am of the opinion that this plumose modification is an abnormality produced by injury to, and subsequent regeneration of, the seta, and, further, the prevalence of this change in spermatophore-bearing females of *Undinula vulgaris* would tend to show that the injury is frequently caused during the act of deposition of the spermatophore by the male.

Genus **Undinula,** Scott.

UNDINULA VULGARIS (Dana).

(Pl. XVII., figs. 1 and 2.)

Calanus vulgaris, Giesbrecht, 1896, p. 318.
———— Thompson, 1899, p. 275.
———— Cleve, 1901, p. 5.
———— A. Scott, 1902, p. 400.
———— Thompson & Scott, 1903, p. 357.
———— Cleve, 1903, p. 357.
———— Cleve, 1904, p. 186.
———— Wolfenden, 1905, p. 994.
Undinula vulgaris, A. Scott, 1909, p. 16.
———— Sewell, 1912, pp. 315 and 356.

Calanus vulgaris var. *plumulosus*, Wolfenden, 1905, p. 994. Pl. XCVI., figs. 21, 22.

Undinula vulgaris var. *plumulosus*, Sewell, 1912, p. 356.

This species was widely distributed throughout the regions investigated. Numerous examples were obtained showing the modified tail setæ as described by Wolfenden (*vide ante*, p. 193), but, as I have already pointed out, I do not consider this condition to be a true variation.

Several examples were obtained which show the double spine on the left side of the posterior thoracic margin. This modification was first described by Giesbrecht (1893, Pl. VII., fig. 28). I have since obtained specimens from the east side of the Bay of Bengal, in the neighbourhood of the Andaman Islands and Mergui Archipelago, in which this condition is even more pronounced. In these specimens the left side of the thoracic margin is considerably swollen, and forms a stout prominence projecting outwards and backwards, and bears two stout spines—the dorsal projecting backwards and somewhat upwards, and the ventral pointing vertically downwards and being considerably swollen at its base.

We thus have three forms, which appear to be quite distinct from one another, for I have up to the present failed to discover any intermediate forms.

UNDINULA DARWINI (Lubbock).

Calanus darwini, Thompson, 1899, p. 275.
——————— Cleve, 1901, p. 5.
——————— A. Scott, 1902, p. 400.
——————— Thompson & Scott, 1903, p. 241.
——————— Cleve, 1903, p. 357.
——————— Cleve, 1904, p. 185.
——————— Wolfenden, 1905, p. 994.
Undinula darwini, A. Scott, 1909, p. 17.
——————— Sewell, 1912, p. 356.
——————— Pesta, 1913, p. 30, fig. 13.

This species was much less common in the Ceylon collections than the preceding, though it is of frequent occurrence in other parts of the Indian Ocean. According to Giesbrecht (1893, Pl. VII., fig. 29), both first and second abdominal segments are furnished with a row of sharp spines on the

posterior margin, and the posterior thoracic margin on the left side is produced backwards in a rectangular projection; but a study of numerous examples from various localities in the Indian Ocean and Bay of Bengal has shown that these characters are subject to very considerable variation. As regards the spinulation of the abdominal segments, many specimens possessed spines only on one of the segments, while in some cases spines were absent altogether. Again, in numerous examples the posterior thoracic margin formed almost a uniform curve, with a very slight rounded projection towards the ventral side; in other cases this prominence was more marked and formed a somewhat triangular prominence, while in a few cases the typical projection was present.

In this species, as in *U. vulgaris*, it would appear that there are three forms of the posterior thoracic margin, which are quite distinct from one another, and a close examination of a large number of specimens has failed to show any correlated change.

UNDINULA DARWINI, var. CAROLI (Giesbrecht).

Calanus caroli, Giesbrecht, 1888, p. 331.
———— Giesbrecht, 1893, p. 91. Pl. VIII., fig. 36.
———— ♂, Wolfenden, 1905, p. 994. Pl. XCVII., fig. 41.
Undinula caroli, A. Scott, 1909, p. 18.

This form was first described by Giesbrecht (*loc. cit.*, 1888), who considered that it was a distinct species. Wolfenden (*loc. cit.*, 1905) obtained examples from the Maldive and Laccadive Archipelagoes, and associated with these were several females, which he considered to be the hitherto-unknown female. According to his brief description these forms were distinguished from the female *Undinula darwini* by the absence of teeth on the distal portion of the margin of exopod 3 in the second and third pairs of swimming feet, and by the presence of a few fine spines on the first basal of the first pair. The absence of the marginal teeth separates these females from the present form, in which these teeth invariably occur exactly as in *U. darwini*, and the fine spines on the first basal of the first leg is a character that I have found

present in *Calanus minor*. As I have previously mentioned (*vide ante*, p. 192), I consider that these forms are in all probability examples of *Calanus minor*.

As A. Scott (*loc. cit.*) has pointed out, the form known as *U. caroli* ♂ is easily recognizable from *U. darwini* ♂ by its constantly smaller size and by the structure of the fifth pair of legs.

In a tow-netting taken at " Investigator " Station No. 470 (Sawi Bay, Kar Nicobar, December 7, 1912), large numbers of both forms were present, associated with numerous examples of *Undinula darwini* ♀; a comparative study of the two forms of male has given the following interesting results.

The proportional lengths of the abdominal and furcal segments in the two forms are—

Undinula darwini: 45 : 41 : 32 : 27 : 25 : 23.
Undinula caroli: 45 : 41 : 31 : 27 : 24 : 22.

The proportional lengths of the antennal joints are as follows :—*

Segments :	1–2.	3–5.	6.	7.	8–9.	10.	11.	12.	13.	14.	15.
U. darwini ..	121	82	26	27	40	26	31	38	46	46	49
U. caroli ..	118	79	24	26	39	28	30	37	45	45	50

Segments :	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.
U. darwini ..	49	51	53	57	46	46	51	51	46	18
U. caroli ..	50	51	53	56	47	47	53	53	50	19

The structure of the first four pairs of swimming legs is exactly similar in the two forms, not only as regards the spinulation, but also in the proportional lengths of the various segments ; thus the proportional lengths of the segments and end spine in the third leg of the two forms are as follows :—

	U. darwini.	*U. caroli.*
First Basal ..	17·9 ..	17·9
Second Basal ..	8·7 ..	8·3
Exopod 1 . ..	11·0 ..	11·0
Exopod 2	15·0 ..	14·5
Exopod 3	28·9 ..	30·0
End spine ..	18·5 ..	18·3
Total length ..	100·0	100·0

* In all cases the total length of the antenna has been taken = 1,000. In this way it is found that comparison between specimens of unequal size is greatly facilitated.

As a result of a careful study, it appears that the sole appreciable difference between these forms lies in the structure of the fifth pair of legs. The question then arises, Are we justified in considering these forms to be distinct " species " ?

Examples of variation in the structure of the sexual appendages have been described in other species, *e.g.*, *Labidocera kröyeri* (Brady) ; and the similarity of the two forms is so close, even to the lengths of the antennal segments and the proportions of the swimming feet, that I submit we could only get such a close resemblance in individuals of the same species, and I believe that the form described by Giesbrecht under the name *Calanus caroli* is merely a variation of the male of *Undinula darwini*.

Genus **Eucalanus**, Dana.

EUCALANUS ATTENUATUS (Dana).

Eucalanus attenuatus, Thompson, 1899, p. 276.
——————— Cleve, 1901, p. 6.
——————— Cleve, 1903, p. 362.
——————— Thompson & Scott, 1903, p. 242.
——————— Wolfenden, 1903–06, p. 996.
——————— Cleve, 1904, p. 189.
——————— Sewell, 1912, p. 357.

A few examples occurred in the collection from the pearl banks,

EUCALANUS SUBTENUIS, Giesbrecht.

Eucalanus subtenuis, Cleve, 1901, p. 7.
——————— Scott, 1902, p. 401.
——————— Cleve, 1903, p. 363.
——————— Thompson & Scott, 1903, p. 242.
——————— Wolfenden, 1903–06, p. 996.
——————— Cleve, 1904, p. 190.
——————— Scott, 1909, p. 21.
——————— Sewell, 1912, p. 358.

This species was on the whole well represented in the collections.

EUCALANUS MUCRONATUS, Giesbrecht.

Eucalanus mucronatus, Cleve, 1901, p. 7.
——————— Cleve, 1903, p. 362.
——————— Cleve, 1904, p. 189.
——————— Wolfenden, 1905, p. 996.
——————— Scott, 1909, p. 20.

Several examples of this species were obtained, although it was by no means common. Hitherto only the female form has been known, but in a tow-netting from Dutch Moderagam Paar, associated with several females was a single male specimen, that shows the following characters :—

♂. Total length, 3·3 mm.

The proportions of the cephalothorax and abdomen are as 7 : 1. The head and first thoracic segments are fused, but the fourth and fifth thoracic segments are separate. The anterior extremity of the head region is produced in a spike, as in the female.

The abdomen consists of four segments, of which the second and third are slightly longer than the first, and the anal segment is quite short. The furcal setæ are asymmetrical, the second seta on the left side being much longer and stouter than the others.

The first antennæ are long, over-reaching the tip of the furcal rami by the last five or six segments. The proportional lengths of the various segments are as follows, and for purposes of comparison I give the lengths of the segments in the female :—

Segments :	1–2.	3.	4.	5.	6.	7.	8–9.	10.	11.	12.	13.
♀. ..	123	25	25	25	25	29	50	34	34	39	43
♂. ..	69 69	24	24	24	24	26	52	38	38	48	52

Segments :	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.
♀. ..	45	49	49	49	53	53	49	49	41	41	29	41
♂. ..	52	53	52	52	48	48	41	41	32	38	27	38

In the main the proportions of the joints are very much the same, the principal differences being the fusion of segments 1 and 2 in the female, and the short 22nd segment in the male.

The second antenna, mouth parts, and *the first four pairs of swimming legs* are similar to those of the female.

The fifth swimming legs are of interest, in that both are present, thus resembling the condition found in *E. attenuatus* (Dana) and *E. elongatus.* The left leg is the longer, and when folded back reaches to the extreme tip of the furcal rami ; the right leg is somewhat stouter, and the terminal segment bears a stout seta.

An immature male was also obtained in the same locality. In this individual the abdomen consists of three segments only, the third not yet having undergone division. Both legs of the fifth pair were present, but were equal in size.

EUCALANUS PILEATUS, Giesbrecht.

Eucalanus pileatus, Thompson & Scott, 1903, p. 242.
——— ——— Cleve, 1904, p. 189.
——— ——— Wolfenden, 1905, p. 996.
——— ——— A. Scott, 1909, p. 21.
——— ——— Sewell, 1912, p. 357.

Only a few examples of this species were obtained.

EUCALANUS MONACHUS, Giesbrecht.

Eucalanus monachus, Cleve, 1901, p. 6.
——— ——— Cleve, 1903, p. 362.
——— ——— Thompson & Scott, 1903, p. 242.
——— ——— Cleve, 1904, p. 189.
——— ——— Wolfenden, 1905, p. 996.
——— ——— A. Scott, 1909, p. 20.
——— ——— Sewell, 1912, p. 357.

This species was fairly well represented in the collections.

EUCALANUS CRASSUS, Giesbrecht.

Eucalanus crassus, Cleve, 1901, p. 6.
——— ——— Scott, 1902, p. 401.
——— ——— Cleve, 1903, p. 362.

Eucalanus crassus, Thompson & Scott, 1903, p. 242.
——————— Cleve, 1904, p. 189.
——————— Wolfenden, 1905, p. 996.
——————— Scott, 1909, p. 19.
——————— Sewell, 1912, p. 357.

Numerous examples were obtained.

EUCALANUS SUBCRASSUS, Giesbrecht.

Eucalanus subcrassus, Giesbrecht, 1888, p. 334.
——————— Giesbrecht, 1891, p. 282.
——————— Giesbrecht, 1896, p. 317.
——————— Cleve, 1903, p. 242.
——————— Thompson & Scott, 1903, p. 242.
——————— Cleve, 1904, p. 190.
——————— Wolfenden, 1905, p. 996.
——————— Scott, 1909, p. 21.
——————— Sewell, 1912, p. 358.
——————— Pesta, 1912, p. 44, fig. 3.
——————— Pesta, 1913, p. 31.

Examples of this species were common; it appears to be widely distributed throughout the Indian Ocean and its offshoots.

Genus **Rhincalanus**, Dana.

RHINCALANUS GIGAS, Dana.

Rhincalanus cornutus, Thompson, 1899, p. 276.
——————— Cleve, 1901, p. 8.
——————— A. Scott, 1902, p. 402.
——————— Thompson & Scott, 1903, p. 242.
——————— Cleve, 1903, p. 368.
——————— Cleve, 1904, p. 196.
——————— Wolfenden, 1905, p. 996.
——————— A. Scott, 1909, p. 23.
——————— Sewell, 1912, p. 358.

Although widely distributed in Indian waters, this species is by no means common in surface collections. A few examples were obtained on the pearl banks.

RHINCALANUS GIGAS, Brady.

(?) *Rhincalanus gigas*, Thompson, 1899, p. 276.
Rhincalanus nasutus, A. Scott, 1902, p. 401.
——————— Cleve, 1903, p. 368.
——————— Thompson & Scott, 1903, p. 242.
——————— Cleve, 1904, p. 196.
——————— Wolfenden, 1905, p. 996.
Rhincalanus gigas, A. Scott, 1909, p. 24.

There is some doubt whether *Rhincalanus gigas*, Brady, and *Rhincalanus nasutus*, Giesbrecht, are synonymous. The differences that distinguish them are, apart from size, which *per se* cannot be regarded as a specific character, of a trivial character, and I am inclined to agree with Scott (*loc. cit.*, 1909) that they are merely forms of one species. Several examples of the form corresponding to *R. nasutus* were obtained on the pearl banks.

Genus **Mecynocera**, Thompson.

MECYNOCERA CLAUSI, Thompson.

Mecynocera clausi, A. Scott, 1902, p. 422.
——————— Cleve, 1903, p. 364.
——————— Thompson & Scott, 1903, p. 242.
——————— A. Scott, 1909, p. 25.

Although by no means common, several examples were obtained, all of which proved to be females.

Genus **Paracalanus**, Boeck.

PARACALANUS ACULEATUS, Giesbrecht.

Paracalanus aculeatus, Giesbrecht, 1888, p. 333.
——————— Giesbrecht, 1891, p. 282.
——————— Giesbrecht, 1893, p. 164. Pl. IX., figs. 20, 26, 30.
Paracalanus parvus, T. Scott, 1894, p. 26. Pl. I., figs. 9–14.
Paracalanus aculeatus, Dahl, 1894, p. 12.

Paracalanus aculeatus, Giesbrecht, 1896, p. 318.
——————— Giesbrecht & Schmeil, 1898, p. 24.
——————— Cleve, 1901, pp. 8 and 47. Pl. VI., figs. 1–10.
Acrocalanus pediger (♂ only), Cleve, 1901, p. 35. Pl. I., figs. 15–20.
Paracalanus aculeatus, A. Scott, 1902, pp. 402 and 423.
——————— Cleve, 1903, p. 366.
——————— Cleve, 1904, p. 194.
——————— Wolfenden, 1905, p. 998. Pl. XCVI., figs. 12–15.
——————— Sars, 1905, p. 2.
Paracalanus clevei, Carl, 1907, p. 7.
Paracalanus aculeatus, A. Scott, 1909, p. 26.
——————— Pesta, 1912, p. 44, fig. 4.
——————— Sewell, 1912, pp. 326 and 358.
——————— Pesta, 1913, p. 31.

As the above synonymy sufficiently indicates, considerable confusion has arisen as regards this species, which was first described by Giesbrecht in 1888 from the female only.

The first record that I can find in the literature of the occurrence of male examples is that by Dahl (1894), but gives no description or figures. Cleve (1901) in the account of his investigations on the Malayan Plankton describes a male form, but from his description it is quite obvious that the specimens before him were immature, and had not adopted the final sexual characters. In the same paper, however, he has described a new species of *Acrocalanus* under the name *A. pediger*. In his description he gives a detailed account of the structure of both male and female forms, and his conclusion, that they are specifically the same, appears to have been accepted. To Carl (1907) belongs the credit of being the first to recognize that the two sexes described by Cleve do not belong to one another, that whereas the so-called female (*vide infra*, p. 211) belongs to the genus *Acrocalanus*, the male is undoubtedly a *Paracalanus* ; he, therefore, separates this latter sex and proposes for it the name *Paracalanus clevei*. During my investigations on the Copepoda of the coast of Burma and on the present collections from the Gulf of Mannar,

I have met with numerous examples of this male form, and a study of its structure has convinced me that it is the true male of *P. aculeatus.*

I give below a description of these individuals :—

♂. Total length, 1·2 mm.

The abdomen and cephalothorax have the relative proportions 1 : 2·6. The head and first thoracic segments are fused, as are also the fourth and fifth thoracic segments, though in the latter region traces of the original line of division are distinctly visible ; the posterior thoracic margin is rounded.

The abdomen consists of five segments, having, with the furca, the following proportional lengths :—

13 : 27 : 20 : 19 : 17 : 12.

The furcal rami are symmetrical, and the proportions of length to breadth are 12 : 9.

The First Antenna.—As in the case of the adult male of *P. parvus*, so here also we find that the basal segments of the antenna become fused together into three joints—the first and second, the third to the sixth, and the seventh and eighth segments respectively being fused. The proportional lengths of the joints are as follows :—

Segments :	1–2.	3–6.	7–8.	9.	10.	11.	12.	13.	14.	15.
	117	157	68	20	26	28	31	40	40	40

Segments :	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.
	43	43	46	46	46	46	43	49	40	31

The antenna when folded back only reaches to the end of the abdomen.

Second Antenna.—This appendage exactly resembles those of the sexually mature males of *P. parvus* (*vide* Giesbrecht, 1893, Pl. IX., fig. 23) and *P. serratipes* (*vide* Sewell, 1912, Pl. XV., fig. 7). As I have already pointed out, the nipple-like termination of the exopodite is a sexual character developed in adult males in the three genera *Paracalanus*, *Acrocalanus*, and *Peizocalanus* (*loc. cit.*, 1912, p. 336).

The mouth parts are similar to those of other adult males of the same genus.

The First Pair of Legs.—Basal 1 bears a single seta on its inner border, and is devoid of any spines either on its surfaces or the external margin.

Basal 2 bears the usual S-shaped seta on its distal inner border, and is likewise devoid of spines.

Exopod 1 bears a single inner seta and has no marginal spine.

Exopod 2 has a single inner seta and bears a short transverse row of needle-like spines on the outer margin.

Exopod 3 has four inner setæ : the usual two marginal spines are present, and in addition there is a row of three or four teeth on the proximal part of the outer border. The end spine is long and slender, being nearly as long as the whole exopodite.

The endopodite is two-jointed, and reaches to the level of the joint between exopods 2 and 3.

The Second Pair of Legs.—Basal 1 bears a single inner seta and no spines.

Basal 2 has no spines or setæ.

Exopod 1 has a well-developed marginal spine, and bears in addition a transverse row of sharp spinules on its outer and posterior aspect. There is a single inner seta.

Exopod 2 bears a marginal spine, and in addition has a row of six curved claw-like spinules on its outer margin, and three triangular spines on its anterior surface. A single seta is present on the inner margin.

Exopod 3 bears two marginal spines and a row of spinules on that part of the outer margin proximal to the first spine. Five setæ arise from the inner border. The terminal spine is a trifle longer than the last segment, in the proportions 9 : 8.

Endopod 1 is small, and the outer border ends in a short spine. A single seta is present.

Endopod 2 bears an oblique curved row of spinules, usually five or six in number on the posterior surface, and a longitudinal row of four or five needle-like spinules on the outer border, which also terminates in a small spinous process. A corona of small spinules is situated on the anterior aspect near the distal margin. A pair of setæ are present on the inner border.

Endopod 3 bears seven setæ, and a few spinules are present posteriorly.

The Third and Fourth Pairs of Legs are very similar to the second pair, but the terminal spine on the fourth exopodite is shorter than the segment preceding it.

The Fifth Pair of Legs.—These, as in all adult males in this genus, are asymmetrical : the left leg consists of a somewhat swollen basal portion and a terminal part composed of four segments. There is an obvious hinge between the basal and terminal portions, and the proportions of the segments are 20 : 15 : 15 : 15 : 12. The last segment ends in two unequal spinous processes, and the penultimate segment bears a single spine at its distal external angle. The right leg is composed of a basal and two free segments. It is much shorter than the left, and ends in two unequal spines.

PARACALANUS PARVUS (Claus.).

Paracalanus parvus, Cleve, 1901, p. 8.
——————— A. Scott, 1902, pp. 402 and 423.
——————— Cleve, 1903, p. 367.
——————— Thompson & Scott, 1903, p. 243.
——————— Cleve, 1904, p. 194.
——————— var. *indicus*, Wolfenden, 1905, p. 998. Pl. XCVI., figs. 7-11 and 16.
——————— A. Scott, 1909, p. 27.
——————— Sewell, 1912, p. 358.

Numerous examples were obtained in the various localities, and its distribution in Indian waters appears to be almost universal. I agree with Scott (*loc. cit.*, 1909) that the minute differences noted by Wolfenden between specimens taken in the North Atlantic Ocean and those from Indian seas are not of sufficient importance to justify the separation of the latter as a special variety.

PARACALANUS SERRATIPES, Sewell.

Paracalanus serratipes, Sewell, 1912, p. 332. Pl. XV figs. 6–10.

This species was first obtained from the Burmese coast; a few examples occurred in the collections from the pearl banks, which undoubtedly belong to the same species; they however, differ slightly from the Burmese specimens in that the terminal segment of the first antenna is somewhat longer in proportion to the preceding segments, but in all other respects these examples agree with the type specimens.

Genus **Acrocalanus**, Giesbrecht.

ACROCALANUS LONGICORNIS, Giesbrecht.

Acrocalanus longicornis, Giesbrecht, 1888, p. 332; Giesbrecht, 1891, p. 282.
———————— Cleve, 1901, p. 5.
———————— Thompson & Scott, 1903, p. 243.
———————— Wolfenden, 1905, p. 1000.
———————— Scott, 1909, p. 28.
———————— Sewell, 1912, p. 358.
———————— Pesta, 1913, p. 13, fig. 14.

Examples of this species were fairly plentiful; it appears to have a wide distribution in Indian seas.

ACROCALANUS GRACILIS, Giesbrecht.

Acrocalanus gracilis, Giesbrecht, 1896, p. 318.
———————— Cleve, 1901, p. 4.
———————— Thompson & Scott, 1903, p. 243.
———————— Cleve, 1903, p. 356.
———————— Cleve, 1904, p. 184.
———————— Wolfenden, 1905, p. 1003.
———————— Scott, 1909, p. 29.
———————— Sewell, 1912, p. 359.

This species was by no means common in the collections all the examples obtained were females.

ACROCALANUS MONACHUS, Giesbrecht.

Acrocalanus monachus, Thompson & Scott, 1903, p. 243.
—————— Cleve, 1903, p. 356.
—————— Wolfenden, 1905, p. 1002.
—————— A. Scott, 1909, p. 30.
—————— Sewell, 1912, p. 359.

A few specimens were obtained.

ACROCALANUS GIBBER, Giesbrecht.

Acrocalanus gibber, Giesbrecht, 1888, p. 332.
—————— Giesbrecht, 1891, p. 282.
—————— Giesbrecht, 1896, p. 318.
—————— Thompson, 1899, p. 276.
—————— Cleve, 1901, pp. 4 and 36. Pl. II., figs. 1–16.
Acrocalanus pediger (♀ part), Cleve, 1901, pp. 5 and 33. Pl. I., figs. 1–14.
Acrocalanus gibber, A. Scott, 1902, pp. 402 and 423.
Acrocalanus gibber, Thompson & Scott, 1903, p. 243.
Acrocalanus pediger, Cleve, 1903, p. 356.
Acrocalanus gibber, Cleve, 1904, p. 184.
—————— Wolfenden, 1905, p. 1003.
—————— A. Scott, 1909, p. 29.
—————— Sewell, 1912, pp. 315 and 359.

Considerable confusion appears to have arisen with regard to this species. The original description was based on female examples only, and this form is easily recognized by the shape of the body and the partial separation of the first thoracic segment from the head region. Cleve (*loc. cit.*, 1901) described a form from the Malay Archipelago which he considered to be the adult male ; these examples, though closely resembling the female as regards the armature of the swimming legs, yet differ considerably in the shape and structure of the cephalothorax. In the same paper he described a form which he named *A. pediger*, but as I have already pointed out (*vide*

ante, pp. 205, 206), the male of this so-called *Acrocalanus* is in reality the male *Paracalanus aculeatus*. The supposed female is undoubtedly an *Acrocalanus*, but is an immature male : the presence of a fifth leg on the left side and the segmentation of the abdomen are sufficient to indicate the sex, and the form apparently corresponds to the male *Acrocalanus gibber*. In the Ceylon collections numerous examples of this immature male were present, and in almost every case were associated with both immature and mature females of the above species.

ACROCALANUS GARDINERI, Wolfenden.

Acrocalanus gardineri, Wolfenden, 1905, p. 1004. Pl. XCVII., figs. 5, 10, 14–21.
———————— Sewell, 1912, p. 359.

The above name was given by Wolfenden to certain adult males that he found in Professor Stanley Gardiner's collections from the Maldive and Laccadive Archipelagoes. In the present collections are several examples that agree very fairly well with Wolfenden's description and figures. These males are usually associated with females that appear to belong to the species *A. gracilis*, and I am inclined to regard *A. gardineri* and *A. gracilis* as synonymous, but, at the present time, the data at my disposal is not sufficient to warrant a definite pronouncement on this point.

ACROCALANUS SIMILIS, sp. nov.

(Pl. XVII., figs. 3–5.)

Several examples, both male and female, of a species of *Acrocalanus* were obtained at several stations in the Gulf of Mannar. At first sight I took these specimens to be examples of *A. inermis*, a species that was described by me (*loc. cit.*, 1912, p. 334, Pl. XVI., figs. 1–9) from the coast of Burma, but a closer examination revealed the fact that, although the resemblance between these two forms is very close, yet they differ in several characters, and I consider that the present examples are in all probability a new species, for which I propose the above name.

♀. Total length, 0·75–0·80 mm.

The proportions of cephalothorax and abdomen are as 3 : The head and first thoracic segment are fused together, as also in adult specimens are thoracic segments 4 and 5, though in immature forms the line of separation between the latter can readily be made out. The posterior thoracic margin is rounded and is devoid of spines. The rostrum is bifid, and is long and slender.

The abdomen consists of four segments, having with the furcal rami the following proportions : 17 : 10 : 10 : 15 : 13. The first segment shows a prominent genital swelling on the ventral aspect.

The first antenna when folded back reaches to the end of the furcal rami, the first and second segments are fused, and the line of separation between segments 8 and 9 is not complete, being only present on the posterior aspect.

The antennal joints have the following proportions :—

Segments :	1–2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
	120	32	32	36	36	29	26	28	28	29	34	38

Segments :	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.
	36	36	40	40	44	44	44	48	44	52	44	60

The mouth parts closely resemble those of *A. inermis*, but the mandible is slightly different ; the arrangement of the teeth is the same, but the separate first tooth has a longer and somewhat narrower basal portion. The swimming legs in these two species are very similar ; in both cases the external margin of the exopodites is devoid of any spines, but in the present form there are no spines on the posterior aspect of exopod 2 in the second to fourth pairs.

♂. Total length, 0·8 mm.

The proportional lengths of cephalothorax and abdomen are 2·25 : 1. The abdomen consists of five segments, having with the furcal rami the proportional lengths 10 : 20 : 15 : 15 : 13 : 12.

First Antenna.—As in other members of this genus, the basal segments are fused together to form two large joints. The proportional lengths of the various joints are as follows :—

Segments :	1–6.	7–8.	9.	10.	11.	12.	13.	14.	15.	16.
	286	73.	24	25	29	29	36	34	39	39

Segments :	17.	18.	19.	20.	21.	22.	23.	24.	25.
	39	41	44	44	48	48	48	44	29

Second Antenna.—As in other members of the genus, in adult males the last joint of the exopodite is devoid of setæ, and forms a nipple-like projection.

The first to fourth pairs of swimming feet are the same as in the female ; the fifth leg on the left side is present, and consists of a somewhat swollen basal segment and four free joints : the terminal joint bears two unequal setæ, and the penultimate joint has a short spine at its distal external angle.

It is obvious that this species is very closely related to *A. inermis*, from the Burma coast, but it differs from it in the following characters :—

(1) The total length is somewhat smaller.

(2) The terminal segment of the first antenna in the female is somewhat longer, and there are no transverse rows of spinules on segments 1–6.

(3) There are no spinules on the posterior thoracic margin.

(4) There are no spines on the posterior aspect of exopod 2 of any of the swimming legs.

(5) The rostrum is long and slender.

It is possible that these differences may be merely due to altered environment, but for the present I prefer to consider the above a new species, and I have therefore given it the name *A. similis*.

Genus **Calocalanus**, Giesbrecht.

CALOCALANUS PAVO (Dana).

Calocalanus pavo, Giesbrecht, 1896, p. 317.
——————— Thompson, 1899, p. 277.
——————— Cleve, 1901, p. 5.

Calocalanus pavo, Scott, 1902, pp. 402 and 423.
———————— Thompson & Scott, 1903, p. 243.
———————— Cleve, 1903, p. 357.
———————— Cleve, 1904, p. 186.
———————— Wolfenden, 1905, p. 999.
———————— Scott, 1909, p. 30.
———————— Sewell, 1912, p. 359.

This species is widely distributed throughout Indian waters. Several examples were obtained on the pearl banks.

CALOCALANUS PLUMULOSUS (Claus.).

Calocalanus plumulosus, A. Scott, 1902, pp. 403 and 423.
———————— Thompson & Scott, 1903, p. 243.
———————— Wolfenden, 1905, p. 999.
———————— A. Scott, 1909, p. 31.
———————— Sewell, 1912, p. 360.

A few examples were obtained from Dutch Moderagam Paar.

Family PSEUDOCALANIDÆ.

Genus **Clausocalanus,** Giesbrecht.

CLAUSOCALANUS ARCUICORNIS (Dana).

Clausocalanus arcuicornis, Thompson, 1899, p. 277.
———————— Cleve, 1901, p. 5.
———————— Thompson & Scott, 1903, p. 243.
———————— Cleve, 1903, p. 359.
———————— Cleve, 1904, p. 188.
———————— Wolfenden, 1905, p. 999.
———————— A. Scott, 1909, p. 32.
———————— Sewell, 1912, p. 360.

Several examples were obtained on the pearl banks.

CLAUSOCALANUS FURCATUS (Brady).

Clausocalanus furcatus, Giesbrecht, 1896, p. 317.
———— Cleve, 1901, p. 5.
———— A. Scott, 1902, pp. 403, 423.
———— Thompson & Scott, 1903, p. 244.
———— Cleve, 1903, p. 360.
———— Cleve, 1904, p. 188.
———— Wolfenden, 1905, p. 999.
———— A. Scott, 1909, p. 32.

Examples of this species were comparatively common; both it and the preceding species appear to have a wide distribution in Indian waters.

Genus **Euchæta**, Philippi.

EUCHÆTA MARINA (Prestandrea).

Euchæta marina, Thompson, 1899, p. 278.
———— Cleve, 1901, p. 7.
———— A. Scott, 1902, p. 403.
———— Thompson & Scott, 1903, p. 244.
———— Cleve, 1903, p. 363.
———— Cleve, 1904, p. 190.
———— Wolfenden, 1905, p. 1007. Pl. C., figs. 19 and 20 (♂).
Euchœta indica, Wolfenden, 1905, p. 1008. Pl. C., figs. 12–16 (♀).
Euchæta marina, A. Scott, 1909, p. 67. Pl. XIX., figs. 9–20.
———— Sewell, 1912, p. 360.
———— Pesta, 1912, p. 45.
———— Pesta, 1913, p. 32.

Several examples of this species, belonging to both sexes, were obtained on the pearl banks.

EUCHÆTA CONCINNA, Dana.

Euchæta concinna, Cleve, 1901, p. 7.
——————— Thompson & Scott, 1903, p. 244.
——————— Cleve, 1903, p. 363.
——————— Wolfenden, 1905, p. 1008. Pl. C., figs. 1–6.
——————— A. Scott, 1909, p. 65. Pl. XIX., figs. 21–27.
——————— Sewell, 1912, p. 360.

This species was by far the most common example of the genus present in the Ceylon collection.

EUCHÆTA WOLFENDENI, Scott.

Euchæta marina, Wolfenden, 1905, p. 1007. Pl. C., figs. 7, 8, 10, 11, 17, 18.
Euchæta wolfendeni, A. Scott, 1909, p. 68. Pl. XVII., figs. 1–12.

Two examples of this species were obtained from Karativu Paar and Dutch Moderagam Paar, respectively.

This species apparently has a wide distribution in Indian waters, for I have recently obtained specimens from tow-nettings taken off the Andaman Islands, and from the Ganjam coast.

Family SCOLECITHRICIDÆ.

Genus **Scolecithrix**, G. Brady.

SCOLECITHRIX DANÆ (Lubbock).

Scolecithrix danæ, Thompson, 1899, p. 279.
——————— Cleve, 1901, p. 9.
——————— A. Scott, 1902, p. 403.
——————— Thompson & Scott, 1903, p. 245.
——————— Cleve, 1903, p. 368.
——————— Cleve, 1904, p. 197.

Scolecithrix danæ, Wolfenden, 1905, p. 1009.
——— A. Scott, 1909, p. 88.
——— Sewell, 1912, p. 360.

This species was comparatively rare in the collection.

Genus **Scolecithricella**, Sars.

SCOLECITHRICELLA PEARSONI, sp. nov.

(Pl. XVII., figs. 6, 7, and Pl. XVIII., figs. 1-4).

A single male and several females of a species of *Scolecithricella* were obtained at Dutch Moderagam and Karativu Paars. The examples appear to belong to a hitherto undescribed species, and I have given it the above name after Dr. J. Pearson, the Director of the Colombo Museum, who kindly entrusted the present collection from the Ceylon pearl banks to my care for the purpose of examination.

The characters of the above species are as follows :—

♀. Total length, 1·0 mm..

The proportions of cephalothorax and abdomen are 3·5 : 1. The cephalothorax is robust, and is uniformly rounded dorsally. The head and first thoracic segment are fused together, as also are thoracic segments 4 and 5. The rostrum consists of two stout spinous processes. The abdomen has four segments, showing with the furcal rami the following relative proportional lengths :—6 : 3 : 3 : 1 : 2.

The first antenna is short and reaches, when folded back, to the posterior end of the thorax : it consists of twenty joints having the following proportional lengths :—

Segments :	1-2.	3.	4.	5.	6.	7.	8-10.	11.	12-13.	14.
	102	27	23	23	23	23	58	23	51	39
Segments :	**15.**	**16.**	**17.**	**18.**	**19.**	**20.**	**21.**	**22.**	**23.**	**24-25.**
	43	47	47	51	51	51	58	66	89	105

The first and second, eighth to tenth, and twelfth and thirteenth segments are respectively fused together, and so are the twenty-fourth and twenty-fifth.

The second antenna and mouth parts are similar to those of other members of the genus.

The First Pair of Legs.—The first basal joint bears no external spine or internal seta; the external margin bears a series of fine curved spinules, diminishing in size proximally; the second basal joint bears no marginal spine, but carries a single seta on its inner distal angle.

The exopodite consists of three segments : exopod 1 bears no marginal spine; exopod 2 has a single spine, as usual; exopod 3 in most cases bears a single spine on the external margin at its distal extremity, but in two of the specimens examined (a ♂ and a ♀) there was a second spine present at the junction of the middle and distal thirds. The end spine is long and slender, and is equal in length to the preceding two segments. The endopodite consists of a single segment having a well-marked rounded swelling on the external border, and across the base of this swelling is a transverse row of needle-like spines.

The Second Pair of Legs.—The first basal bears a single seta internally, and is finely serrated on the proximal two-thirds of the outer margin. The second basal is produced at both the internal and external distal angles in a triangular spinous process.

The exopodite consists of three segments: exopod 1 bears a single seta internally, and externally is armed with a long spine that reaches as far as the base of the spine on the succeeding segment; exopod 2 bears a single internal seta, and the external spine extends well beyond the base of the proximal spine on exopod 3. On the posterior aspect are two rows of small spinules, one row extends vertically down the centre of the segment and the second runs horizontally along the distal margin ; exopod 3 bears four setæ on its internal margin, and externally is armed with three teeth of more or less equal size. On its posterior aspect, this segment carries three curved rows of spinules. Terminally, the end spine is broad and somewhat curved, having a finely-serrated outer margin.

The endopodite is two-jointed: endopod 1 bears a single inner seta, and externally is produced at its distal extremity

in a sharp spinous projection; exopod 2 bears five setæ and terminates in a small apical spinous process, while on its posterior aspect it carries a series of sharp needle-like spines.

The Third Pair of Legs.—Basal 1 bears a single internal seta, and is finely serrated on its external margin ; basal 2 has a spine-like projection on both inner and outer ends of the distal margin. Both exopodite and endopodite consist of three segments : exopod 1 has a single external spine and one internal seta ; exopod 2 is similarly provided ; exopod 3 bears three external spines ; all the marginal spines are of equal size. In addition, certain of these segments are armed with rows of spinules ; the second basal segment carries a series of small spines on the triangular projection of its distal margin, behind the base of exopod 1 ; exopod 2 bears a transverse row of spines parallel to its posterior distal margin, and exopod 3 bears two rows of spines, one distally along the transverse border and one shaped like ٦ about the middle of its length, both on the posterior aspect.

Endopod 1 bears a single internal seta, and terminates externally in a sharp spine-like process ; exopod 2 is similarly provided, and in addition is armed with long needle-like spines on its posterior aspect. Endopod 3 bears five setæ, and is armed with spines like the preceding segment.

The fourth pair of legs are similar to the third pair, but are armed with a transverse row of spines of the first basal segment, and the marginal serration on this segment is absent.

The fifth pair of legs have the form characteristic of the genus. The single segment bears three spines ; the outer is extremely small and arises from the external margin ; the second arises distally and is somewhat longer ; the third spine is large and projects inwards from the inner margin ; it is finely serrated on its internal border.

♂. The total length, 7·0 mm.

The proportional lengths of cephalothorax and abdomen are 3 : 1. The abdomen consists of four segments having, with the furcal rami, the following proportions : 15 : 25 : 20 : 22 : 10.

The first antenna consists of eighteen joints, having the following relative lengths :—

Segments:	1.	2.	3.	4.	5.	6.	7.	8–14.	15.
	54	32	29	25	25	25	25	132	32

Segments:	16.	17.	18.	19.	20.	21.	22.	23.	24–25.
	50	64	68	68	71	75	43	86	96

The eighth to the fourteenth segments inclusive appear to have fused to form a single joint.

The second antenna, mouth-parts, and swimming legs are the same as those of the female.

The Fifth Pair of Legs.—Each leg has a stout basal segment and a short one-jointed endopodite ; the right exopodite consists of three segments ; exopod 2 bears a row of small spines on the distal part of its inner margin ; exopod 3 is somewhat claw-shaped, terminating in a sharp point and having a swollen base. The proportional lengths of the basal joint and exopods are 24 : 22 : 16 : 8 ; the relative length of the endopod is 8.

The left leg has the basal joint produced in a somewhat swollen rounded projection distally. The exopod is two-jointed, each joint being of nearly equal length ; the terminal joint is tapered, ending in a sharp point. The endopod is short and spine-like.

Tribe **HETERARTHANDRIA.**

Family CENTROPAGIDÆ.

Genus **Centropages,** Kroyer.

CENTROPAGES FURCATUS (Dana).

Centropages furcatus, Giesbrecht, 1889, Sem. 1, p. 811.
———— Giesbrecht, 1891, p. 282.
———— Giesbrecht, 1893.
———— Giesbrecht, 1896, p. 317.
———— Thompson, 1899, p. 279.
———— Cleve, 1901, p. 5.
———— A. Scott, 1902, pp. 403 and 423.

Centragages furcatus, Cleve, 1903, p. 359.
———— Thompson & Scott, 1903, p. 246.
———— Cleve, 1904, p. 187.
———— Wolfenden, 1905, p. 1016.
———— A. Scott, 1909, p. 113.
———— Pesta, 1912, p. 46, fig. 5.
———— Sewell, 1912, pp. 315 and 360.
———— Pesta, 1913, p. 32.

This species is widely distributed throughout Indian waters, and numerous examples were obtained from the pearl banks.

CENTROPAGES ORSINII, Giesbrecht.

Centropages orsinii, Giesbrecht, 1889, Sem. 1, p. 811.
———— Giesbrecht, 1891, p. 282.
———— Giesbrecht, 1893.
———— Giesbrecht, 1896, p. 317.
———— Cleve, 1901, p. 5.
———— A. Scott, 1902, pp. 404 and 423.
———— Cleve, 1903, p. 359.
———— Thompson & Scott, 1903, p. 247.
———— Wolfenden, 1905, p. 1015. Pl. XCVIII., figs. 1, 4, 8, 11, 12 ♂, and 5, 13 ♀.
———— A. Scott, 1909, p. 115.
———— Pesta, 1912, p. 46, fig. 6.
———— Sewell, 1912, pp. 315 and 362.
———— Pesta, 1913, p. 32.

Examples of this species were of common occurrence, and were widely distributed throughout the areas under investigation.

CENTROPAGES TENUIREMIS, Thompson & Scott.

Centropages tenuiremis, Thompson & Scott, 1903, p. 247. Pl. I., figs. 14–18.

Centropages arabicus, Cleve, 1903, p. 371. Pl. XVI., figs. 1–9, and Pl. XVII., fig. 1.

Centropages tenuiremis, Sewell, 1912, p. 363. Pl. XXIV., figs. 6–7.

This species has now been reported from the Arabian Sea, the coastal waters of Ceylon, and the coast of Burma. It was present in several of the tow-nettings from the pearl banks, but never in any considerable numbers.

CENTROPAGES DORSISPINATUS, Thompson & Scott.

Centropages dorsispinatus, Thompson & Scott, 1903, p. 247. Pl. I., figs. 19–25.

Centropages notoceras, Cleve, 1903, pp. 359 and 373. Pl. XVII., figs. 2–10, and Pl. XVIII., fig. 1.

——————— Sewell, 1912, p. 360.

Several examples of this species were taken in a tow-netting at Kilakarai at the head of the Gulf of Mannar. As I have already pointed out (*loc. cit.*), the descriptions given by Thompson & Scott and Cleve differ in several details; the present specimens agree exactly with those from the Persian Gulf and from Burma.

CENTROPAGES ELONGATUS, Giesbrecht.

Centropages elongatus, Giesbrecht, 1896, pp. 317, 322. Pl. V., figs. 3–6.

——————— A. Scott, 1902, p. 404. Pl. I., figs. 13, 14.

——————— Cleve, 1903, p. 359.

——————— Thompson & Scott, 1903, p. 246.

——————— Wolfenden, 1905, p. 1014. Pl. XCVIII., figs. 2, 3, 9, 10, 14.

——————— A. Scott, 1909, p. 113.

This species is comparatively rare in the present collections. A few examples of both sexes were obtained at Dutch Moderagam, Krusadai, and Jokenpiddi Paars.

CENTROPAGES GRACILIS (Dana).

Centropages gracilis, Cleve, 1901, p. 5.
——————— Cleve, 1903, p. 359.
——————— Thompson & Scott, 1903, p. 247.
——————— Wolfenden, 1905, p. 1013. Pl. XCVIII., fig. 7.
——————— A. Scott, 1909, p. 114.

A single example of a mature female was obtained at Jokenpiddi Paar.

CENTROPAGES TRISPINOSUS, sp. nov.
(Pl. XVIII., figs. 5–8.)

A single example, a female, of apparently a new species of *Centropages*, was taken in a tow-netting at Kilakarai. The single specimen obtained presents several characteristic features in which it differs from all previously described specimens, and I have therefore given it the above name.

♀ Total length, 1·4 mm.

The proportional lengths of cephalothorax and abdomen are 3 : 1. The head and first thoracic segment are quite separate, as also are thoracic segments four and five. The dorsum is uniformly rounded. The posterior thoracic margin is rounded, and is armed with three short spines situated rather towards the ventral side. The rostrum consists of two slender processes. The abdomen possesses three segments having, with the furcal rami, the proportional lengths 4 : 3 : 2 : 2. The genital segment is somewhat barrel-shaped, and has a rounded swelling on the dorsal apect.

The first antenna, when folded back, reaches to the end of the abdomen. The number and relative lengths of the basal segments are not easily determined; apparently several segments are fused together to form the second joint, and the eighth and ninth are also partially fused, and the twenty-fourth and twenty-fifth segments completely so.

The proportional lengths of the various joints are as follows :—

Segments :	1.	2–4.	5.	6.	7.	8–9.	10.	11.	12.	13.
	43	43	14	17	28	37	23	26	37	63

Segments :	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24–25.
	68	68	77	86	88	77	51	46	31	34	43

The Fifth Pair of Legs.—Both rami are three-jointed.

Exopod 1 bears a marginal spine, but has no internal seta ; exopod 2, in addition to the single external marginal spine, bears the usual spine on its inner border. This spine is long and has a somewhat swollen base ; it tapers gradually to a fine point and bears no teeth on its surface. Exopod 3 has two marginal spines and a finely serrated end-spine.

The endopodite reaches to the level of the joint between exopods 2 and 3. Endopod 1 presents a well-marked rounded swelling at its distal external angle.

The remaining appendages appear to be very similar to those of *Centropages alcocki* (Sewell, 1912, p. 338, Pl. XVII., figs. 1–7), but the serrations on the terminal spines of the swimming feet are not so coarse and are less widely separated.

Genus **Pseudodiaptomus**, Herrick.

Pseudodiaptomus aurivillii, Cleve.

Pseudodiaptomus aurivillii, Cleve, 1901, p. 48. Pl. VI., figs. 11–22, and Pl. VII., figs. 1, 2.
—————— Thompson & Scott, 1903, p. 248. Pl. II., figs. 24–26.
—————— A. Scott, 1909, p. 116.
—————— Sewell, 1912, p. 363.

Numerous examples of both sexes were obtained in the present collections. The male was first obtained by Thompson and Scott, but as they give no description of its structure I give below a brief account of some of the more salient features.

♂. Total length, 1·1 mm.

Proportional lengths of cephalothorax and abdomen 2 : 1. The head and first thoracic segment are fused completely and thoracic segment 4 and 5 partially so; the postero-lateral border of the fifth segment is, as in the female, armed with a large backwardly projecting spine. The rounded anterior "forehead" terminates ventrally in a bifid rostrum composed of long fleshy processes.

The abdomen consists of five segments having, with the furca, the following relative proportions:—16 : 25 : 24 : 24 : 11 : 21. Segments 2 to 4 inclusive are armed round their posterior borders with a series of triangular spines.

The first antenna on the right side is modified to form a grasping organ; it is composed of twenty joints, having the following relative proportional lengths:—

Segments:	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
	95	52	24	14	14	19	14	14	24	28
Segments:	11.	12.	13.	14.	15.	16.	17.	18.	19–20.	21–23.
	24	24	28	66	57	62	43	118	114	165

The knee-joint is situated between segments 18 and 19, and the "Endabschnitt" consists of two joints only, segments 19 and 20 and 21 to 23 being respectively fused together. Segment 10 bears a long spine-like seta, and segments 12 to 16 are all armed with needle-like spines; the seventeenth segment bears a lamellar process on its anterior aspect; both segments of the knee-joint are armed with lamellar plates, that on the proximal segment being armed with needle-like teeth, while that on the distal is unarmed.

The Second Antenna.—The two rami are of nearly equal length; the last joint of the exopodite is swollen and nipple-shaped. The endopodite is of the usual type.

The Second Maxilliped.—Basal 1 is three-fifths as long as broad; it bears four setæ on its anterior border and carries a single stout spine-like seta distally; basal 2 is beset with fine hairs proximally, and about the middle of its length bears three stout setæ; it is about twice as long as broad. The terminal portion of the appendage consists of the usual five segments.

The First Pair of Swimming Legs.—Basal 1 bears an internal seta, and is armed with a few spines on its anterior aspect near the base ; basal 2 bears a corona of spines distally on its outer and anterior surfaces. The rami are in exact agreement with Cleve's original description (*loc. cit.*, 1901).

The remaining swimming legs are similar to those of the female, and the fifth pair of legs correspond exactly with the description given by Thompson and Scott.

PSEUDODIAPTOMUS SERRICAUDATUS (T. Scott).

Pseudodiaptomus serricaudatus, A. Scott, 1902, p. 404. Pl. I., fig. 6.
—————— Cleve, 1903, p. 368.
—————— Thompson & Scott, 1903, p. 248.
—————— Cleve, 1904, p. 196.
—————— Tollinger, 1911, p. 177.

Examples of this species were of common occurrence throughout the area under investigation.

Family TEMORIDÆ.

Genus **Temora**, W. Baird.

TEMORA DISCAUDATA, Giesbrecht.

Temora discaudata, Giesbrecht, 1889, Sem. 1, p. 814.
—————— Giesbrecht, 1891, p. 282.
—————— Giesbrecht, 1896, p. 317.
—————— Thompson, 1899, p. 280.
—————— Cleve, 1901, p. 9.
—————— A. Scott, 1902, pp. 405 and 423.
—————— Cleve, 1903, p. 369.
—————— Thompson & Scott, 1903, p. 248.
—————— Cleve, 1904, p. 198.
—————— Wolfenden, 1905, p. 1023.

Temora discaudata, A. Scott, 1909, p. 118.
——— Pesta, 1912, p. 47, fig. 7.
——— Sewell, 1912, p. 365. Pl. XXII., figs. 8, 9.

Numerous examples of this species were obtained; as the above list of references shows, it is widely distributed throughout Indian waters.

TEMORA STYLIFERA (Dana).

Temora stylifera, Thompson, 1899, p. 280.
——— Cleve, 1901, p. 9.
——— A. Scott, 1902, p. 404.
——— Cleve, 1903, p. 369.
——— Thompson & Scott, 1903, p. 249.
——— Cleve, 1904, p. 198.
——— Wolfenden, 1905, p. 1023.
——— Sewell, 1912, p. 366.

The above species also appears to be widely distributed throughout Indian waters; it was common in the present collections.

TEMORA TURBINATA (Dana).

Temora turbinata, Giesbrecht, 1889, Sem. 1, p. 814.
——— Giesbrecht, 1891, p. 282.
——— Giesbrecht, 1896, p. 318.
——— Thompson & Scott, 1903, p. 249.
——— Scott, 1909, p. 118.
——— Pesta, 1912, p. 48, fig. 8.
——— Sewell, 1912, p. 366.
——— Pesta, 1913, p. 32.

This species also was common in the collections, and appears to be widely distributed in these waters.

Family LUCICUTIIDÆ.

Genus **Lucicutia,** Giesbrecht.

LUCICUTIA FLAVICORNIS (Claus.).

Leuckartia flavicornis, Cleve, 1901, p. 7.
Lucicutia flavicornis, A. Scott, 1902, p. 405.
——————— Thompson & Scott, 1903, p. 249.
——————— Cleve, 1903, p. 364.
——————— Cleve, 1904, p. 192.
——————— Wolfenden, 1905, p. 1012.
——————— A Scott, 1909, p. 125.
——————— Sewell, 1912, p. 366.

A few examples only were obtained.

Genus **Metacalanus,** Cleve.

METACALANUS AURIVILLII, Cleve.

Metacalanus aurivillii, Cleve, 1901, pp. 7, 43. Pl. IV., figs. 16–25, and Pl. V., figs. 1–6.
——————— Thompson & Scott, 1903, p. 243. Pl. II., figs. 18–20.
——————— A. Scott, 1909, p. 146.

Numerous examples of this species were obtained. It has now been reported from the Malay Archipelago and Ceylon, and I have myself found it in the Plankton of the Tenasserim coast. It was also of frequent occurrence in the "Siboga" collection, and is probably widely distributed throughout the Indian seas. Owing to its small size, however, it is very liable to be overlooked.

Family CANDACIIDÆ.

Genus **Candacia,** Dana.

CANDACIA ÆTHIOPICA (Dana).

Candacia æthiopica, Thompson, 1899, p. 281.
——————— Scott, 1902, p. 405.

Candacia æthiopica, Thompson & Scott, 1903, p. 250.
———— Cleve, 1903, p. 358.
———— Scott, 1909, p. 151.
———— Sewell, 1912, p. 366.

Only a few examples were obtained in the present collections.

CANDACIA CATULA (Giesbrecht).

Candacia catula, Giesbrecht, 1896, p. 317.
———— Cleve, 1901, p. 5.
———— Scott, 1902, p. 405.
———— Thompson & Scott, 1903, p. 250.
———— Cleve, 1903, p. 358.
———— Cleve, 1904, p. 186.
———— Wolfenden, 1905, p. 1012.
———— Scott, 1909, p. 152.
———— Sewell, 1912, p. 367.

This species appears to be widely distributed throughout Indian waters. It was by no means common on the pearl banks, but several examples of both sexes were obtained.

CANDACIA BRADYI, A. Scott.

Candacia bradyi, Scott, 1902, p. 406. Pl. I., figs. 9–12 (♂).
———— Thompson & Scott, 1903, p. 250.
Candacia tuberculata, Wolfenden, 1905, p. 1013.
Candacia bradyi (♂ part), Carl, 1907, p. 9. Pl. I., figs. 11 and 14, and Pl. XCVI., figs. 40–44 (♂).
———— Scott, 1909, p. 156. Pl. XLVII., figs. 1–9 (♂).
———— Pesta, 1912, p. 49, fig. 9 (♀).
———— Sewell, 1912, p. 366. Pl. XXIII., figs. 6 and 7 ( ).

This species appears to have a fairly wide distribution throughout Indian waters. Its occurrence has now been reported from localities ranging from the Persian Gulf to Amboina and the Phillippines.

CANDACIA DISCAUDATA, Scott.

Candacia bradyi (♀ part), Carl, 1907, p. 9. Pl. I., figs. 8–10, 12–13.
Candacia discaudata, Scott, 1909, p. 157. Pl. XLVII., figs. 10–20.
——————— Sewell, 1912, p. 367.

The first to describe this species was Dr. J. Carl; he, however, only had the female sex before him, and he made the mistake of associating his examples with *Candacia bradyi*, Scott, of which at that time only the male was known. Scott, who does not appear to have been acquainted with Carl's Paper, re-described the species from the Siboga collection under the above name.

Several examples of both sexes were obtained from the pearl banks, so the known distribution of this form is extended considerably to the westward.

CANDACIA PACHYDACTYLA, Dana.

Candace pachydactyla, Cleve, 1901, p. 5.
Candacia pachydactyla, Thompson & Scott, 1903, p. 251.
——————— Cleve, 1903, p. 358.
——————— Cleve, 1904, p. 187.
——————— Wolfenden, 1905, p. 1013.
——————— Scott, 1909, p. 153.
——————— Sewell, 1912, p. 368.

Although this species appears to be widely distributed throughout Indian waters, it was of rare occurrence in the present collection.

CANDACIA TRUNCATA, Dana.

Candacia truncata, Thompson, 1899, p. 282.
——————— Scott, 1902, p. 405.
——————— Thompson & Scott, 1903, p. 250.
——————— Cleve, 1903, p. 358.

Candacia truncata, Cleve, 1904, p. 187.
——————— Wolfenden, 1905, p. 1013.
——————— Scott, 1909, p. 155.
——————— Sewell, 1912, p. 368.

This species also appears to have a wide distribution, but only a single specimen was found in the collection.

Family PONTELLIDÆ.

Genus **Calanopia**, Dana.

CALANOPIA ELLIPTICA (Dana).

Calanopia elliptica, Giesbrecht, 1896, pp. 317, 325. Pl. V., figs. 7–9.
——————— Thompson, 1899, p. 282.
——————— Cleve, 1901, p. 5.
——————— A. Scott, 1902, pp. 406 and 423.
——————— Thompson & Scott, 1903, p. 251.
——————— Cleve, 1903, p. 356.
——————— Wolfenden, 1905, p. 1023.
——————— A. Scott, 1909, p. 177. Pl. XLVIII., figs. 1–5.
——————— Pesta, 1912, p. 50, fig. 10.
Calanopia sp. (= ♂ juv.), Pesta, 1912, p. 52, fig. 12.
Calanopia elliptica, Sewell, 1912, p. 368.
——————— Pesta, 1913, p. 32.

This species is of comparatively common occurrence in Indian waters; examples of both sexes were plentiful in the Ceylon collection. The form described by Dr. Pesta (*loc. cit.*, 1912) is, in my opinion, a young and immature male; the form of the fifth appendage is exactly similar to that found in young males just before they undergo the sexual moult.

CALANOPIA AURIVILLII, Cleve.

Calanopia aurivillii, Cleve, 1901, p. 37. Pl. II., figs. 17–23, and Pl. III., figs. 1–10.
——————— Thompson & Scott, 1903, p. 251.

Calanopia minor, Sewell, 1912, p. 368.
Calanopia aurivillii, A. Scott, 1909, p. 181. Pl. XLVIII., figs. 16–20.

Numerous examples of both sexes were obtained in the Ceylon collections; they agree exactly with the descriptions of Cleve and Scott. I have re-examined the specimens which I recorded from the coast of Burma under the name *C. minor* and I find that for the most part they do not belong to that species, but are examples of *C. aurivillii*.

CALANOPIA THOMPSONI, A. Scott.

Calanopia thompsoni, Scott, 1909, p. 17*a*. Pl. XLIX. figs. 1–8.
——— Sewell, 1912, p. 368.

Numerous examples of this species were obtained from the Ceylon pearl banks; they were especially common in a tow-netting from Marichchukkaddi Bay. Its occurrence in these waters increases the range of this species very considerably.

CALANOPIA MINOR, A. Scott.

Calanopia minor, A. Scott, 1902, p. 406. Pl. I., figs. 1–5.
——— Thompson & Scott, 1903, p. 251.
——— Cleve, 1903, p. 356.
——— Wolfenden, 1905, p. 1023.
——— A. Scott, 1909, p. 177. Pl. XLVIII., figs. 6–10.
——— Pesta, 1912, p. 51.
——— Sewell, 1912, p. 368.

A few examples of this species were obtained on the pear banks, but on the whole it was comparatively rare.

Genus **Labidocera**.

LABIDOCERA ACUTA (Dana).

Labidocera acutum, Giesbrecht, 1889, p. 27.
——— Giesbrecht, 1891, p. 282.

Labidocera acuta, Giesbrecht, 1896, p. 317.
——————— Thompson, 1899, p. 282.
——————— Cleve, 1901, p. 7.
——————— A. Scott, 1902, p. 407.
——————— Thompson & Scott, 1903, p. 251.
——————— Cleve, 1903, p. 363.
——————— Cleve, 1904, p. 191.
——————— Wolfenden, 1905, p. 1016.
——————— Scott, 1909, p. 164.
——————— Pesta, 1912, p. 52, fig. 13.
——————— Sewell, 1912, p. 368.
——————— Pesta, 1913, p. 32.

This species was of common occurrence in the Ceylon collections. As the above list of references indicates, it has a wide distribution throughout Indian waters.

LABIDOCERA KROYERI (Brady).

Labidocera kroyeri, Cleve, 1901, p. 7.
——————— Thompson & Scott, 1903, p. 251.
——————— Scott, 1909, p. 165.
——————— Sewell, 1912, p. 369.
Labidocera kroyeri var. *stylifera*, Thompson & Scott.
Labidocera kroyeri var. *stylifera*, Thompson & Scott, 1903, p. 252. Pl. II., figs. 8, 9.
——————————— Sewell, 1912, p. 369.
Labidocera kroyeri var. *burmanica*, Sewell.
Labidocera kroyeri var. *burmanica*, Sewell, 1912, p. 369. Pl. XXIII., figs. 4 and 5.

Examples of this species were common throughout the area under investigation. A peculiarity of this species is the degree of variation exhibited by the males. Thompson and Scott described two varieties from the Ceylon coast, var. *stylifera* and var. *gallensis*, and I have previously described a third, var. *burmanica*, from the Tenasserim coast. The vast majority of the males obtained in the present collection

belonged to the variety of *stylifera;* a few examples of the *burmanica* variety and two examples of the normal male were also obtained.

LABIDOCERA MINUTA, Giesbrecht.

Labidocera minutum, Giesbrecht, 1889, p. 27.
———— Giesbrecht, 1891, p. 28e.
———— Cleve, 1901, p. 7.
Labidocera minuta, A. Scott, 1902, p. 407.
———— Thompson & Scott, 1903, p. 251.
———— Cleve, 1903, p. 363.
———— Wolfenden, 1905, p. 1018. Pl. XCVIII., figs. 18, 24, 25, 29, 32, 37
———— A. Scott, 1909, p. 167.
———— Pesta, 1912, p. 53, fig. 14.
———— Sewell, 1912, p. 370.

Examples of this species, though not common, were yet of fairly frequent occurrence in the collections; the species appears to be widely distributed throughout Indian waters.

LABIDOCERA PAVO, Giesbrecht.

(Pl. XXI., figs. 1–3.)

Labidocera pavo, Giesbrecht, 1889, p. 27.
———— Giesbrecht, 1891, p. 282.
———— Cleve, 1901, p. 7.
———— Thompson & Scott, 1903, p. 251.
———— Cleve, 1903, p. 364.

Numerous examples of this species, including the hitherto unknown male, were obtained in some of the tow-nettings from the pearl banks.

♂. Total length, 2·2 mm.

Proportional lengths of cephalothorax and abdomen about 4 : 1. The head and first thoracic segments are fused together, and there is a well-marked groove across the dorsal aspect of the "neck."

The fourth and fifth thoracic segments are also fused. The posterior thoracic margin is rounded, and is armed with a small spine. The head is furnished with a pair of large eye lenses, and the ventral lens is well developed and of a plum-colour. The rostrum is bifid, and is composed of two slender spines; there is no rostral lens. The abdomen consists of five segments, having, with the furcal rami, the following proportional lengths :—27 : 32 : 32 : 16 : 9 : 38.

The first antenna, when folded back, reaches to the middle of the abdomen; that on the left side consists of twenty-two joints, having the following proportional lengths, and for purposes of comparison I also give the lengths of the joints in the female :—

Segments:	1.	2.	3.	4.	5.	6.	7-8.	9.	10.	11.	12.
♂ ..	65	65	15	11	13	26	49	26	23	38	39
♀ ..	81	81	17	13	14	28	50	22	22	36	38

Segments:	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.
♂ ..	36	41	73	73	81	86	54	52	52	41	41
♀ ..	36	45	66	66	78	81	52	48	50	38	38

Segments 7 and 8 are partially fused together. The right antenna is modified to form a grasping organ; it consists of nineteen joints, having the following proportional lengths :—

Segments:	—	—	—	—	—	—	—	—	12.	13.
♂ ..	56	75	18	14	13	32	37	42	26	24

Segments:	14.	15.	16.	17.	18.	19–21.	22.	23.	24–25.
♂ ..	40	72	87	70	106	119	89	40	40

Segments 11, 12, and 13 each bear a minute spine on the anterior surface; the seventeenth segment bears a curved lamellar plate very similar to that present in *L. detruncata;* the eighteenth segment is armed with a lamellar plate carrying a number of fine acicular spines, and the nineteenth segment carries a raised tooth-plate very similar to that of *L. detruncata,* but only reaching about three-fourths the length of the segment, not beyond the distal joint as in *L. detruncata,* nor is it so rounded at its extremity.

The Fifth Pair of Legs.—That on the right side has much the same shape as that of *L. detruncata,* but the proximal process is not so stout; the left leg also has a similar structure,

but the spines on the distal segment are somewhat differently arranged. The first spine arises from the middle of the external margin and the remaining three from the extreme tip ; the inner margin is beset with fine hairs.

It is evident that this species closely resembles *L. detruncata*, but in both sexes there are certain constant differences that render identification comparatively easy.

LABIDOCERA PECTINATA, Thompson & Scott.

Labidocera pectinata, Thompson & Scott, 1903, p. 252. Pl. II., figs. 10–14.

Labidocera similis, Cleve, 1903, pp. 364 and 378. Pl. XIX., figs. 4–6.

Labidocera pectinata, Sewell, 1912, p. 370. Pl. XXIII., figs. 8–9.

A single example of this rare species was obtained from a tow-netting taken at Paumben.

Genus **Pontella**, Dana.

PONTELLA DANÆ, var. CEYLONICA, Thompson & Scott.

Pontella danæ var. *ceylonica*, Thompson & Scott, 1903, p. 252. Pl. II., figs. 1–5.

———————— Sewell, 1912, p. 370.

A few examples were obtained ; they agree exactly with the original figures and description.

PONTELLA INVESTIGATORIS, Sewell.

Pontella investigatoris, Sewell, 1912, p. 371. Pl. XXIII., figs. 1–3.

This species was first described by me from male examples taken on the coast of Burma. Several specimens were obtained in the present collections from the Ceylon pearl banks, and these agree exactly with the types. One cannot help

remarking on the frequency with which these males are associated with the females of the preceding species, and in neither case have any corresponding members of the opposite sex been obtained. The male, *P. danæ*, as described, is obviously not the same as the present species, but it is possible that the variety of the female, as described by Thompson & Scott, is in reality a different species, and I am inclined to regard it as the female of *P. investigatoris*. There is a very close similarity in the general structure, and especially is this seen in the relative lengths of the antennal joints in the two forms. I give below the proportional lengths of the joints in the antenna of *P. danæ* var. *ceylonica* (♀), and those of the unaltered antenna of *P. investigatoris* (♂).

Segments:	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
P. danæ; var. *ceylonica*, ♀..	95	71	16	17	20	22	20	20	27	23	22	38
P. investigatoris, ♂ ..	98	71	16	16	18	20	18	18	25	20	20	35

Segments:	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.
P. danæ; var. *ceylonica*, ♀..	38	42	47	61	61	66	71	49	47	50	34	43
P. investigatoris, ♂ ..	34	34	44	59	60	70	76	56	56	56	40	48

It is obvious that there is a fairly close resemblance between these two forms, and I am inclined to believe that the form described by Thompson & Scott as *P. danæ* var. *ceylonica* is in reality not a variety of Giesbrecht's species, but the female of *P. investigatoris*.

PONTELLA FERA, Dana.

Pontella fera, Giesbrecht, 1889, p. 28.
———— Giesbrecht, 1891, p. 282.
———— A. Scott, 1902, p. 408.
———— Thompson & Scott, 1903, p. 252.
———— Wolfenden, 1905, p. 1021.
———— A. Scott, 1909, p. 159.

Although recorded from various parts of the Indian Ocean and its offshoots, this species would appear to be by no means

common; a single example (female) was found in the Ceylon collection.

PONTELLA SECURIFER, Brady.

Pontella securifer, Giesbrecht, 1889, p. 27.
——— Giesbrecht, 1891, p. 282.
——— Thompson & Scott, 1903, p. 252.
——— Cleve, 1904, p. 195.
——— Wolfenden, 1905, p. 1021.
Pontella spinipes (♂), Wolfenden, 1905, p. 1020.
Pontella securifer, A. Scott, 1909, p. 160.
——— Sewell, 1912, p. 372.

A single specimen (♂) was obtained from the pearl banks.

Genus **Pontellopsis**, Brady.

PONTELLOPSIS ARMATA (Giesbrecht).

Monops armatus, Giesbrecht, 1889, p. 28.
——— Giesbrecht, 1891, p. 282.
——— Cleve, 1901, p. 7.
Pontellopsis armata, Thompson & Scott, 1903, p. 253.
——— Wolfenden, 1905, p. 1022. Pl. XCIX., figs. 1–3.
——— A. Scott, 1909, p. 170.

A single example of a male of this species was found in the present collection.

PONTELLOPSIS HERDMANI, Thompson & Scott.

Pontellopsis herdmani, Thompson & Scott, 1903, p. 253. Pl. II., figs. 15–17.
Pontellopsis macronyx, A. Scott, 1909, p. 137. Pl. LIV., figs. 1–10.
Pontellopsis herdmani, Sewell, 1912, p. 375. Pl. XXIV., fig. 5.

Several examples of this species were obtained from the pearl banks. Though differing in several unimportant details from the original description, I have no doubt that the above is the correct specific identity. In the present specimens, the genital segment of the abdomen in the female frequently bears a small spine on the dorsal surface and somewhat towards the left side, in addition to the two on the right side described by Thompson & Scott; in all my specimens the furcal setæ are plumose.

PONTELLOPIS KRAMERI (Giesbrecht).

Monops krameri, Giesbrecht, 1896, pp. 317, 323.
Pontellopsis krameri, A. Scott, 1902, p. 423. Pl. I., figs. 7, 8, and Pl. II., figs. 1, 2.
———— Thompson & Scott, 1903, p. 253.
———— Wolfenden, 1905, p. 1021. Pl. XCVIII., figs. 39–41.
———— A. Scott, 1909, p. 171.
———— Sewell, 1912, p. 376.

Several examples of the male of this species were obtained, but no corresponding females.

PONTELLOPSIS PERSPICAX (Dana).

Pontellopsis perspicax, Thompson & Scott, 1903, p. 253.
———— A. Scott, 1909, p. 171.

A single female belonging to the above species was taken at Periya Paar.

PONTELLOPSIS REGALIS (Dana).

Pontellopsis regalis, Thompson, 1899, p. 283.
Monops regalis, Cleve, 1901, p. 7.
Pontellopsis regalis, Thompson & Scott, 1903, p. 253.
Monops regalis, Cleve, 1903, p. 364.
Pontellopsis regalis, A. Scott, 1909, p. 171.
———— Sewell, 1912, pp. 315, 376.

A single example was obtained in the present collection.

Genus **Pontellina**, Dana.

PONTELLINA PLUMATA (Dana).

Pontellina plumata, Giesbrecht, 1889, p. 29.
———————— Giesbrecht, 1891, p. 282.
———————— Thompson, 1899, p. 283.
———————— Cleve, 1901, p. 8.
———————— A. Scott, 1902, p. 408.
———————— Thompson & Scott, 1903, p. 253.
———————— Cleve, 1903, p. 367.
———————— Cleve, 1904, p. 195.
———————— Wolfenden, 1905, p. 1022.
———————— A. Scott, 1909, p. 175.
———————— Sewell, 1912, p. 354.

A few examples of this species were taken in the present collections. Though widely distributed, it does not appear to be common in Indian waters.

Genus **Acartia**, Dana.

ACARTIA CENTRURA, Giesbrecht.

Acartia centrura, Giesbrecht, 1889, p. 25.
———————— Giesbrecht, 1891, p. 282.
———————— Thompson & Scott, 1903, p. 254.

Several examples were obtained in the present collections.

ACARTIA DANÆ, Giesbrecht.

Acartia danæ, Cleve, 1903, p. 355.
———————— Cleve, 1904, p. 184.
———————— Wolfenden, 1905, p. 1023.
———————— A. Scott, 1909, p. 187.
———————— Sewell, 1912, p. 376.

A few examples of this species were present.

ACARTIA ERYTHRÆA, Giesbrecht.

Acartia erythræa, Giesbrecht, 1889, p. 26.
——— Giesbrecht, 1891, p. 282.
——— Giesbrecht, 1896, p. 317.
——— Thompson, 1899, p. 284.
——— Cleve, 1901, p. 4.
——— A. Scott, 1902, pp. 408, 423.
——— Thompson & Scott, 1903, p. 254.
——— Cleve, 1903, p. 355.
——— Wolfenden, 1905, p. 1023.
——— A. Scott, 1909, p. 187.
——— Pesta, 1912, p. 53, fig. 16.
——— Sewell, 1912, p. 377.
——— Pesta, 1913, p. 32.

Numerous examples of both sexes were obtained; this species is both widely distributed and of common occurrence in Indian waters.

ACARTIA NEGLIGENS, Dana.

Acartia negligens, Cleve, 1901, p. 4.
——— A. Scott, 1902, p. 408.
——— Thompson & Scott, 1903, p. 254.
——— Wolfenden, 1905, p. 1023.
——— A. Scott, 1909, p. 188.

Examples of this species were obtained at several of the localities on the pearl banks, though in no case was it present in any considerable numbers.

ACARTIA SPINICAUDA, Giesbrecht.

Acartia spinicauda, Cleve, 1901, p. 4.
——— Cleve, 1903, p. 355.
——— A. Scott, 1909, p. 188.
——— Sewell, 1912, pp. 315 and 377.

Only a few examples of this species were present.

ACARTIA BISPINOSA, Carl.

Acartia bispinosa, Carl, 1907, p. 13. Pl. I., figs. 1, 2.
——————— Pesta, 1912, p. 54, fig. 17.

This species was first described by Carl from Amboina, and since then it has been recorded by Pesta from the Persian Gulf. Numerous examples were obtained in the Ceylon collections, and the specimens agree closely with previous descriptions. According to Carl and Pesta, there are only two spines on the postero-lateral thoracic margin, but this appears to be a variable character, as in some of the present examples an extra spine occurred, making three in all. Only the males of this species have up to the present time been discovered.

ACARTIA PIETSCHMANI, Pesta.

Acartia pietschmani, Pesta, 1912, p. 55, fig. 18.
——————— Pesta, 1913, p. 33.

This species was described from the Persian Gulf, where examples of the adult female and some immature males were obtained, and has since been obtained in the Arabian Sea. Several examples were found in the Ceylon collections that correspond with this form ; they at first sight are likely to be mistaken for *A. crythræa*, but they are of smaller size, and the structure of the fifth pair of legs in the female of the two species is different.

ACARTIA AMBOINENSIS, Carl.

(Pl. XIX., figs. 1–7).

Acartia amboinensis, Carl, 1907, p. 12. Pl. I., figs. 3–5.

Numerous examples were found in the present collections. This species was described by Carl from male examples only ; these very closely resemble the male of *A. erythræa*, but there are certain constant differences in the structure of the fifth

pair of thoracic appendages; and on the posterior thoracic margin, in most cases, there are two small spines situated dorsally, though in some instances as many as three are present, whereas in *A. erythræa* there is only one.

Associated with these males in the present collections were numerous females.

♀. Total length, 1·2 mm.

Proportional lengths of cephalo-thorax and abdomen, 14 : 3.

The head and first thoracic segment are separate, but the last two thoracic segments are fused. The posterior thoracic margin bears a large lateral spine, as *A. erythræa*, and one, sometimes two, small spines dorsally. The rostrum consists of a pair of slender spines.

The abdomen consists of three segments having, with the furcal rami, the following proportions :—7 : 3 : 2 : 3. The first segment is armed near its posterior border with a pair of small spines dorso-laterally; the second segment is devoid of spines. The furcal setæ are all of the same thickness, but the second is somewhat longer than the others.

The first antenna, when folded back, reaches to the end of the first abdominal segment. It consists of eighteen joints, having the following proportions :—

Segments :	1.	2–4.	5–6.	7–8.	9–10.	11.	12–13.	14.	15–16.
	49	81	35	22	97	51	111	57	92

Segments :	17.	18.	19.	20.	21.	22.	23.	24.	25.
	62	57	49	46	57	32	51	38	13

The first joint bears a long straight spine on its anterior aspect, and two small spines posteriorly; the second joint bears a large curved hook on its posterior border; and the fourth joint is armed with two small spines posteriorly.

The second antenna is as figured.

The first pair of swimming legs consist of a basal portion and two-jointed exopodite and endopodite : exopod 1 has a fine seta-like marginal spine; exopod 2 bears three margin spines, the proximal of which is long and stout and reaches well beyond the end of the terminal segment, while the distal two are slender and seta-like; the end spine is slender and in length nearly equals the whole exopodite.

The third and fourth pairs of legs are very similar to *A. crythræa.*

The fifth pair of legs bear a short external seta; and the terminal process is long and curved and is very slightly swollen at the base.

These examples very closely resemble the females of *A. crythræa,* but the spinulation of the basal segments of the first antenna and the form of the fifth pair of legs are different and are quite characteristic.

ACARTIA SOUTHWELLI, sp. nov.

(Pl. XIX., figs. 8, 9.)

Several examples, both male and female, of what appears to be a new species of *Acartia* were obtained from Kilakarai. The chief characters of these specimens are as follows :—

♀. Total length, 0·8 mm.

Proportional lengths of cephalothorax and abdomen, 35 : 1.

The head and first thoracic segment are separate, but the fourth and fifth thoracic segments are fused together.

The posterior thoracic margin is rounded, and is devoid of spines. The anterior extremity is rounded, and bears a pair of slender curved rostral filaments.

The abdomen consists of three segments having, with the furcal rami, the following proportions :—26 : 13 : 10 : 15; all the segments are devoid of any trace of spines, and the genital segment is somewhat swollen and rounded. The furcal rami are nearly as wide as long, 9 : 10.

The first antennæ, when folded back, reach just beyond the posterior thoracic margin; each consists of twenty joints, the more proximal of which are, as usual, very indistinctly marked off from one another, so that it is a matter of some difficulty to determine their exact limits; they appear to have the following proportions :—

Segments :	1.	2–4.	5–6.	7–8.	9–10.	11.	12.	13–14.	15.	16.
	73	54	24	24	20	49	43	125	43	68

Segments :	17.	18.	19.	20.	21.	22.	23.	24.	25.
	58	68	49	49	49	34	63	44	20

The second antenna and *mouth-parts* are similar to other embers of the genus.

The fifth pair of legs consist of a fairly long basal joint bearing a minute seta on its external margin distally, and having a long and delicate terminal spine. This spine is curved, and has a markedly swollen base.

♂. Total length, 0·75 mm.

The proportional lengths of cephalothorax and abdomen are, 1.

The abdomen consists of four segments having, with the furcal rami, the proportional lengths :—18 : 14 : 3 : 9 : 10.

The first antenna on the right side is, as usual, modified to form a grasping organ; it consists of fifteen separate joints having the following proportions :—

Segments :	1–4.	5–6.	7–8.	9.	10.	11.	12.	13.	14.
	121	66	66	18	36	36	97	42	48

Segments :	15.	16.	17.	18.	19–21.	22–25.
	96	115	109	42	66	42

The fifth pair of legs are of the usual type; the right leg forms a claw, the second segment bears a somewhat quadrangular process on its inner border, and the third segment terminates in two short unequal spines.

Genus **Acartiella**, nov.

I propose to establish a new genus for the reception of certain *Acartia*-like species which have been obtained from Indian coastal waters. The first species I described under the name *Acartia tortaniformis* (Sewell, 1912, p. 346, Pl. XXI., figs. 1–10), from the Chittagong region and Rangoon river estuary on the coast of Burma ; a second species was obtained in a tow-netting taken off Kilakarai.

These two species differ from those of the genus *Acartia*, in that in the female the fifth pair of legs possesses both an exopodite and endopodite, and in the male the right leg forms a well-developed clasping apparatus ; in both species the rostrum is absent ; the first antenna of the female consists of

21 joints, segments 2–6 being fused together, while in the male the grasping antenna resembles that of an *Acartia ;* the abdomen is long, and terminates in two long furcal rami which are symmetrical.

Acartiella kempi, sp. nov.

(Pl. XX., figs. 1–5, and Pl. XXI., fig. 4.)

♀. Total length, 1·0 mm.

Proportional lengths of cephalothorax and abdomen, 2·5 : 1. The head and first thoracic segment are separate, thoracic segments 4 and 5 are fused together, the posterior thoracic margin is rounded and devoid of spines. The anterior head region is uniformly rounded, and the rostrum is absent.

The abdomen consists of three separate segments having, with the furcal rami, the following proportions :—32 : 15 : 25 : 34. The first segment is devoid of spines, thus differing from *A. tortaniformis.*

The furcal rami are long and slender as in the genus *Tortanus*, but are symmetrical.

The first antenna, when folded back, reaches to the last abdominal segment ; it consists of twenty-one separate joints, having the following proportional lengths :—

Segments :	1.	2–6.	7.	8.	9.	10.	11.	12.	13.	14.	15.
	53	116	53	32	35	39	28	35	32	39	35

Segments :	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.
	35	53	63	63	53	60	46	63	46	21

None of the segments possess spines.

The second antenna resembles that present in the genus *Acartia ;* it has a long endopodite and a short exopodite. In this respect this species differs very considerably from *Acartiella tortaniformis* (Sewell), the only other member of the genus in which this appendage is of a somewhat unusual form.

The mouth-parts and *swimming legs* closely resemble those of *A. tortaniformis.*

The fifth pair of legs consists of a short, stout, basal portion carrying a single plumose seta, and both exopodite and endopodite are present; the exopodite consists of a long slightly curved process, terminating in a sharp point and bearing a single seta-like spine on its external margin at about the junction of the middle and distal thirds; the endopodite is short and conical. There are no teeth on either ramus, as is the case in *A. tortaniformis*.

♂. Total length, 0·9 mm.

Proportional lengths of cephalothorax and abdomen, 2 : 1. The abdomen consists of five segments having, with the furcal rami, the following proportional lengths:—12 : 22 : 17 : 11 : 11 : 35.

The first antenna on the right side is modified to form a grasping organ. It consists of eighteen separate joints, having the following proportional lengths:—

Segments:	1.	2–4.	5.	6.	7.	8.	9.	10.	11.	12.
	66	84	25	11	22	33	25	40	25	33

Segments:	13.	14.	15.	16.	17.	18.	19–21.	22–25.
	44	36	44	40	76	120	131	145

The second to fourth segments inclusive are fused together to form a single joint; the "endabschnitt" consists of two joints, segments 19–21 and 22–25, respectively, being fused. The seventeenth segment bears a row of needle-like teeth on its anterior margin; the eighteenth segment bears a row of needle-like teeth anteriorly, and distally is armed with two claw-like spines, of which the proximal is the larger; the nineteenth segment carries a tooth-plate armed with acicular teeth, and the plate is produced beyond the distal extremity of the joint in a sharp *spinous* process.

The mouth-parts and *swimming legs* are the same as in the female.

The Fifth Pair of Legs.—Each consists of three segments, and that on the right side forms a well-developed grasping apparatus, as figured.

I have much pleasure in dedicating this species to Mr. S. W. Kemp, of the Indian Museum, who kindly made the collections for me at Kilakarai and Paumben, in which this species occurred.

Genus **Tortanus**, Giesbrecht.

Tortanus gracilis (Brady).

(Pl. XXI., fig. 5.)

Tortanus gracilis, Cleve, 1901, p. 5. Pl. VII., figs. 11–14.
——————— A. Scott, 1902, p. 423.
——————— Thompson & Scott, 1903, p. 254.
——————— Cleve, 1903, p. 369.
——————— Wolfenden, 1905, p. 1026.
——————— A. Scott, 1909, p. 190.
——————— Sewell, 1912, p. 377.

Several examples of this species, belonging to both sexes, were present in the Ceylon collections.

Both Cleve and Wolfenden are inclined to believe that this species and the following, *T. forcipatus*, are synonymous, but a careful study of the examples in the present collection has shown that this view is absolutely untenable. For the purpose of comparison I give below a few details of structure in this species.

♀. *The first antenna* consists of seventeen joints, having the following relative proportions :—

Segments :	1–7.	8.	9–10.	11.	12.	13–14.	15.	16.	17.
	87	18	52	28	28	74	52	52	59

Segments :	18.	19.	20.	21.	22.	23.	24.	25.
	67	68	81	65	61	80	91	37

Segments 1–7, 9–10, and 13–14 are, apparently, respectively fused together. The fifth pair of legs, as pointed out by Cleve (*loc. cit.*, 1901), are asymmetrical, but the degree of asymmetry is very slight, and not in the least comparable to that present in the corresponding appendages in *T. forcipatus*.

♂. *The grasping antenna* consists of sixteen joints, having the following proportional lengths :—

Segments :	1–5.	6.	7.	8.	9.	10.	11.	12.
	62	11	19	16	30	27	24	24

Segments :	13.	14.	15.	16.	17.	18.	19–21.	22–25.
	49	67	67	62	76	81	133	252

The fifth pair of legs correspond exactly with the description and figures given by Cleve (*loc. cit.*, 1901).

TORTANUS FORCIPATUS (Giesbrecht).

(Pl. XXI., fig. 6.)

Tortanus forcipatus, Thompson & Scott, 1903, p. 254.

This species was first described by Giesbrecht from female examples only. In the present collection numerous examples were found, and associated with them were several examples of a hitherto undescribed male, which I have no doubt is the unknown male of this species.

♂. Total length.

Proportional lengths of cephalothorax and abdomen, 5 : 3. The head and all the thoracic segments are separate. The abdomen consists of five segments having, with the furcal rami, the following proportional lengths :—14 : 15 : 12 : 9 : 13 : 70. In *T. gracilis* the corresponding proportional lengths are: 14 : 14 : 11 : 8 : 15 : 72. The furcal rami are symmetrical ; four furcal setæ arise from the distal end of the ramus, and of these the second is the longest. The fifth seta is quite short, and arises from the lateral border.

The grasping antenna consists of sixteen joints, having the following proportional lengths :—

Segments :	1–5.	6.	7.	8.	9–10.	11.	12.	13.
	114	13	20	20	26-29	23	23	43

Segments :	14.	15.	16.	17.	18.	19–21.	22–25
	62	59	62	75	98	150	·183

So far as its structure is concerned, the grasping antenna very closely resembles that of *T. gracilis* : segments 17, 18, and 19–21 are all armed with rows of needle-like teeth.

The fifth pair of legs show distinct differences from the corresponding appendages of *T. gracilis* ; these can best be seen by comparing the figures given.

♀. In the female *T. forcipatus* the first antenna consists apparently of seventeen joints, having the following proportional lengths :—

Segments :	1–7.	8.	9–10.	11.	12.	13–14.	15.	16.
	99	23	57	28	28	51.	42	48

Segments :	17.	18.	19.	20.	21.	22.	23.	24.	25.
	54	59	68	82	71	71	79	92	48

The fifth pair of legs are markedly asymmetrical and correspond exactly with the figure given by Giesbrecht (1893, Pl. 31, fig. 15).

The occurrence of the hitherto unknown male is of interest and the differences that it presents to the male of *T. gracilis* show that these two forms are undoubtedly different species.

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APPENDIX.

List of Collecting Stations.

Kilakarai.

12/20–2–13	..	Tow-net in shallow water, 0–2 fathom.
13–2–13	..	Tow-net from weeds.
,,	..	Tow-net from weeds in 2 ft. of water.
,,	..	Tow-net from weeds over shallow water.
,,	..	Tow-net over weeds, 4 ft. of water.
17–2–13	..	⌓ net in 3 fathoms.
,,	..	Tow net over 3 fathoms of water.

Between Kilakarai and Apa Island.

14–2–13	..	Tow net over 2 to 3 fathoms.

Paumben.

22–2–13	..	Tow-net over 4 ft. of water.
,,	..	⌓ net in 2 ft. of water through "Yostera" bed.
24–2–13	..	Surface tow-net.
25–2–13	..	⌓ net, on shelly ground in 1 fathom.

Anaivilundan Paar.

Date.	Time.	Depth in Fathoms of Net.	Position.
8–11–08	7.30 A.M.	0	—
13–11–08	8 A.M.	0	Dutch Anaivilundan.

Nadukudda Paar.

Date.	Time.	Depth in Fathoms of Net.	Position.
4–11–08	12 noon	0	—
4–11–08	5 P.M.	0	—
5–11–08	8 A.M.	0	—
5–11–08	12 noon	0	—
6–11–08	7.30 A.M.	0	West side.
14–11–08	12.30 P.M.	0	Dutch Nadukudda.

Koopay Paar.

Date.	Time.	Depth in Fathoms of Net.	Position.
11–11–08	12 noon	0	—
11–11–08	5 P.M.	0	—
12–11–08	8.30 A.M.	0	South.
4–11–08	5 P.M.	0	West.

Vankalai Paar.

Date.		Time.		Depth in Fathoms of Net.		Position.
11-4-07	..	5-5.30 P.M.	..	6	..	—
30-10-08	..	8 A.M.	..	0	..	—
30-10-08	..	5 P.M.	..	0	..	—
31-10-08	..	7.30 A.M.	..	0	..	—
31-10-08	..	12 noon	..	0	..	—
31-10-08	..	5 P.M.	..	0	..	—
15-10-08	..	8.30 A.M.	..	0	..	1½ mile W.N.W.
15-11-08	..	5 P.M.	..	0	..	do.
16-11-08	..	8.30 A.M.	..	0	..	2½ miles N.N.W.

Periya Paar.

7-2-08	..	8-8.30 A.M.	..	0	..	South end.
7-2-08	..	8-8.30 A.M.	..	6	..	South end.
22-2-08	..	8 A.M.	..	0	..	—
17-11-08	..	5.30 P.M.	..	0	..	—
18-11-08	..	7.30 A.M.	..	0	..	1 mile W. by S.
19-11-08	..	12 noon	..	0	..	1½ mile N. by W.
19-11-08	..	5 P.M.	..	0	..	2½ miles N.W.
20-11-08	..	12 noon	..	0	..	2½ miles N. by W.
20-11-08	..	5.30 P.M.	..	0	..	2½ miles W.S.W.
22-11-08	..	5.30 P.M.	..	0	..	—
23-11-08	..	8 A.M.	..	0	..	South shoal.

Periya Paar Karai.

9-4-07	..	5-5.30 P.M.	..	6	..	—
10-4-07	..	8-8.30 A.M.	..	0	..	—
11-4-07	..	8-8.30 A.M.	..	6	..	—
17-11-08	..	8.30 A.M.	..	0	..	—
17-11-08	..	12 noon	..	0	..	—

Aripu Paar East.

3-12-08	..	8 A.M.	..	0	..	—

North Cheval Paar.

9-4-07	..	8-8.30 A.M.	..	6	..	—
7-11-07	..	4-4.30 P.M.	..	0	..	—
7-11-07	..	4-4.30 P.M.	..	5	..	—
19-11-07	..	8-8.30 A.M.	..	6	..	—

North-East Cheval Paar.

6-11-07	..	8-8.30 A.M.	..	0	..	—
6-11-07	..	8-8.30 A.M	..	5	..	—
6-11-07	..	4-4.30 P.M.	..	0	..	—
7-11-07	..	8-8.30 A.M.	..	0	..	—
7-11-07	..	8-8.30 A.M.	..	5	..	—
20-11-07	..	8-8.30 A.M.	..	0	..	—

Date.	Time.	Depth in Fathoms of Net.	Position.
8–11–08	7.30 A.M.	0	—
27–11–08	5.30 P.M.	0	—
28–11–08	7.30 A.M.	0	—
	Mid-East Cheval Paar.		
7–2–07	5–5.30 P.M.	0	—
8–2–07	8–8.30 A.M.	0	—
8–2–07	12–12.30 P.M.	0	—
8–2–07	12–12.30 P.M.	6	—
3–11–07	4–4.30 P.M.	0	—
4–11–07	8–8.30 A.M.	0	—
4–11–07	8–8.30 A.M.	4	—
4–11–07	4–4.15 P.M.	0	—
4–11–07	4–4.15 P.M.	4	—
5–11–07	8–8.30 A.M.	0	—
5–11–07	8–8.30 A.M.	4	—
20–11–07	4–4.30 P.M.	0	—
21–11–07	8–8.30 A.M.	0	East side.
3–2–08	4–4.30 P.M.	0	do.
18–2–09	7.30 A.M.	0	—
	South-East Cheval Paar.		
6–2–07	5–5.30 P.M.	0	—
7–2–07	8–8.30 A.M.	0	—
23–11–07	8–8.30 A.M.	0	North edge.
16–2–09	5.30 P.M.	0	—
16–2–09	5.30 P.M.	6	—
	South Cheval Paar.		
19–2–09	5 P.M.	6	—
20–2–09	7 A.M.	0	—
20–2–09	7 A.M.	6	—
	South-West Cheval Paar.		
20–2–09	5.30 P.M.	0	—
21–2–09	7.30 A.M.	6	—
21–2–09	12 noon	0	—
	Mid-West Cheval Paar.		
22–1–07	3.45–4 P.M.	6	—
23–1–07	8–9 A.M.	6	—
23–1–07	12.30–1 P.M.	6	—
23–1–07	5–5.45 P.M.	6	—
24–1–07	8–9 A.M.	0	—
24–1–07	8–9 A.M.	6	—
24–1–07	12.30–1.30 P.M.	0	—

Date.		Time.		Depth in Fathoms of Net.		Position.
25–1–07	..	8–9 A.M.	..	0	..	West edge.
25–1–07	..	8–9 A.M.	..	$8\frac{3}{4}$	..	do.
6–2–07	..	12–12.30 P.M.		0	..	—
9–2–07	..	8–8.30 A.M.	..	0	..	—
9–2–07	..	8–8.30 A.M.	..	6	..	—
30–3–07	..	8–8.30 A.M.	..	0	..	—
30–3–07	..	8–8.30 A.M.	..	6	..	—
30–3–07	..	5–5.30 P.M.	..	0	..	—
30–3–07	..	5–5.30 P.M.	..	6	..	—
31–3–07	..	8–8.30 A.M.	..	0	..	—
31–3–07	..	8–8.30 A.M.	..	6	..	—
31–3–07	..	5–5.30 P.M.	..	6	..	—
1–4–07	..	8–8.30 A.M.	..	0	..	—
1–4–07	..	8–8.30 A.M.	..	6	..	—
1–4–07	..	5–5.30 P.M.	..	6	..	—
2–4–07	..	8–8.30 A.M.	..	0	..	—
2–4–07	..	8–8.30 A.M.	..	6	..	—
6–2–08	..	8–8.30 A.M.	..	0	..	—
		West Cheval Paar.				
28–11–07	..	8–8.30 A.M.	..	0	..	—
28–11–07	..	8–8.30 A.M.	..	6	..	—
		North-West Cheval Paar.				
4–2–08	..	4–4.30 P.M.	..	0	..	—
		Mid-Cheval Paar.				
4–2–08	..	8–8.30 A.M.	..	0	..	East side.
		North-Central Cheval Paar.				
26–11–08	..	12 noon	..	0	..	—
26–11–08	..	5.30 P.M.	..	0	..	—
27–11–08	..	8 A.M.	..	0	..	—
		Challai Paar.				
1–2–08	..	8–8.30 A.M.	..	0	..	—
1–2–08	..	4–4.30 P.M.	..	0	..	1 mile west.
2–2–08	..	8–8.30 A.M.	..	0	..	do.
3–2–08	..	8–8.30 A.M.	..	0	..	3 miles west.
		Silavatturai Paar.				
28–3–09	..	12 noon	..	0	..	—
		Kondachi Paar.				
21–10–08	..	8 A.M.	..	0	..	—
22–10–08	..	8–8.30 A.M.	..	0	..	—
29–10–08	..	8 A.M.	..	0	..	Near to.

Date.	Time.	Depth in Fathoms of Net.	Position.
	Jaggerboom Bank.		
22–2–09	7 30 A.M.	0	—
	Moderagam Paar.		
6–4–07	5–5 30 P.M.	0	South.
6–4–07	5–5.30 P.M.	6	do.
7–4–07	8–8.30 A.M.	0	do.
7–4–07	8–8.30 A.M.	6	do.
28–11–07	4–4.40 P.M.	0	do.
29–11–07	8–8.30 A.M.	0	do.
29–11–07	8–8.30 A.M.	5	do.
14–2–08	4–4.30 P.M.	6	North end.
17–2–08	4–4.30 P.M.	0	do.
14–2–09	12 noon	0	North.
14–2–09	5.30 P.M.	0	do.
15–2–09	7.30 A.M.	0	do.
15–2–09	5.30 P.M.	0	—
15–2–09	5.30 P.M.	6	—
16–2–09	7.30 A.M.	0	South.
	Old Dutch Jaggerboom Bank.		
10–2–09	5 P.M.	0	—
10–2–09	5 P.M.	6	—
11–2–09	7.30 A.M.	0	—
11–2–09	12 noon	0	—
	Marichchukkaddi Bay.		
10–2–07	8–8.30 A.M.	0	—
11–2–07	8–8.30 A.M.	0	—
12–2–07	8–8.30 A.M.	0	—
13–2–07	8–8.30 A.M.	0	—
14–2–07	7.30–8 A.M.	0	—
17–2–07	7.30–8 A.M.	0	—
18–2–07	7.30–8 A.M.	0	—
14–11–07	3.45–4 P.M.	0	—
10–2–08	8–8.30 A.M.	0	2 miles out.
	Kudrimalai Paar.		
11–2–08	10–10.30 A.M.	0	—
	Dutch Moderagam Paar.		
27–1–07	5.30–6 P.M.	6	—
28–1–07	8–8.30 A.M.	6	—
28–1–07	12–12.30 P.M.	0	—
28–1–07	12–12.30 P.M.	6	—
28–1–07	5–5.30 P.M.	0	—
28–1–07	5–5.30 P.M.	6	—
29–1–07	8–8.30 A.M.	0	—
29–1–07	8–8.30 A.M.	6	—
20–2–07	7.30–8 A.M.	0	—

Date.	Time.	Depth in Fathoms of Net.	Position.
20-2-07	7.30-8 A.M.	6	—
20-2-07	5-5.30 P.M.	6	—
21-2-07	5-5.30 P.M.	0	—
21-2-07	5-5.30 P.M.	6	—
22-2-07	8-8.30 A.M.	0	—
22-2-07	8-9 A.M.	0	—
22-2-07	5-5.30 P.M.	0	—
22-2-07	5-5.30 P.M.	6	—
23-2-07	8-9 A.M.	6	—
23-2-07	5-5.30 P.M.	0	—
24-2-07	8-8.30 A.M.	0	—
24-2-07	8-8.30 A.M.	6	—
24-2-07	12-12.30 P.M.	0	—
24-2-07	5-5.30 P.M.	0	—
24-2-07	5-5.30 P.M.	6	—
25-2-07	8-8.30 A.M.	0	—
25-2-07	5-5.30 P.M.	0	—
25-2-07	5-5.30 P.M.	6	—
26-2-07	8-8.30 A.M.	0	—
26-2-07	5-5.30 P.M.	0	—
26-2-07	5-5.30 P.M.	6	—
27-2-07	8-8.30 A.M.	6	—
27-2-07	5-5.30 P.M.	0	—
27-2-07	5-5.30 P.M.	6	—
28-2-07	8.8.30 A.M.	0	—
28-2-07	5-5.30 P.M.	0	—
1-3-07	8-8.30 A.M.	0	—
1-3-07	8-8.30 A.M.	6	—
1-3-07	5-5.15 P.M.	0	—
2-3-07	5-5.15 P.M.	0	—
2-3-07	5-5.15 P.M.	6	—
3-3-07	8-8.30 A.M.	6	—
9-2-09	7 A.M.	0	—
10-2-09	12 noon	0	1½ mile to the east.
10-2-09	12 noon	6	do.
13-2-09	7.30 A.M.	6	Old Dutch site.

Karaitivu Paar.

Date.	Time.	Depth in Fathoms of Net.	Position.
14-11-06	9 A.M.	0	—
14-11-06	9 A.M.	6	—
26-1-07	12-12.30 P.M.	0	—
29-1-07	5-5.30 P.M.	0	—
30-1-07	12-12.30 P.M.	0	—
30-1-07	5-5.30 P.M.	6	—
31-1-07	8-8.30 A.M.	0	—
31-1-07	12-12.30 P.M.	6	—
4-3-07	5-5.30 P.M.	0	—
4-3-07	5-5.30 P.M.	6	—
5-3-07	8-8.30 A.M.	0	—

Date.	Time.	Depth in Fathoms of Net.	Position.
5–3–07	8–8.30 A.M.	6	—
5–3–07	5–5.30 P.M.	0	—
5–3–07	5–5.30 P.M.	6	—
6–3–07	8–8.30 A.M.	0	—
6–3–07	5–5.30 P.M.	6	—
8–3–07	8–8.30 A.M.	0	—
8–3–07	8–8.30 A.M.	6	—
14–3–07	5–5.30 P.M.	0	—
14–3–07	5–5.30 P.M.	6	—
15–3–07	8–8.30 A.M.	6	—
15–3–07	5–5.30 P.M.	6	—
16–3–07	8 A.M.	0	—
16–3–07	8 A.M.	6	—
18–3–07	5–5.30 P.M.	6	—
19–3–07	8 A.M.	6	—
20–3–07	8–8.30 A.M.	0	—
20–3–07	5–5.30 P.M.	6	—
21–3–07	8–8.30 A.M.	0	—
21–3–07	8–8.30 P.M.	6	—
21–3–07	5–5.30 P.M.	0	—
14–2–08	4–4.30 P.M.	0	—
14–2–08	4–4.30 P.M.	6	—
15–2–08	8–8.30 A.M.	0	—
7–2–09	7 A.M.	0	2½ miles to the eastward.

Karaitivu Shoal, North End.

Date.	Time.	Depth in Fathoms of Net.	Position.
1–11–07	4–4.30 P.M.	0	—
1–11–07	4–4.30 P.M.	4	—
2–11–07	8–8.45 A.M.	0	—
2–11–07	8–8.45 A.M.	4	—
2–11–07	4–4.45 P.M.	0	—
2–11–07	4–4.45 P.M.	4	—

Alanturai Paar.

Date.	Time.	Depth in Fathoms of Net.	Position.
2–1–07	8–8.30 A.M.	0	—
2–1–07	8–8.30 A.M.	6	—
2–1–07	12–12.30 P.M.	0	—
1–2–07	8–8.30 A.M.	0	—
1–2–07	12–12.30 P.M.	0	—
1–2–07	12–12.30 P.M.	6	—
1–2–07	5–5.30 P.M.	0	—
1–2–07	5–5.30 P.M.	6	—
2–2–07	5–5.30 P.M.	0	—
3–2–07	8–8.30 A.M.	6	—
12–3–07	5–5.30 P.M.	6	—
13–3–07	5–5.30 P.M.	0	—
13–3–07	5–5.30 P.M.	6	—
14–3–07	8–8.30 A.M.	0	—
14–3–07	8–8.30 A.M.	6	—

Date.	Time.	Depth in Fathoms of Net.	Position.
27-3-07	8-8.30 A.M.	0	—
27-3-07	8-8.30 A.M.	6	—
27-3-07	5-5.30 P.M.	6	—
28-3-07	8-8.30 A.M.	0	—
28-3-07	5-5.30 P.M.	0	—
13-4-07	5-5.30 P.M.	0	—
13-4-07	5-5.30 P.M.	6	—
14-4-07	8-8.30 A.M.	0	—
14-4-07	8-8.30 A.M.	6	—
16-4-07	5-5.30 P.M.	0	—
17-4-07	8-8.30 A.M.	0	—
17-4-07	5-5.30 P.M.	0	—
18-4-07	8-8.30 A.M.	0	—
18-4-07	5-5.30 P.M.	6	—
19-4-07	8-8.30 A.M.	6	—
1-2-09	7.30 A.M.	0	—
1-2-09	12.30 P.M.	0	—
4-2-09	5.30 P.M.	0	—
5-2-09	12 noon	0	—
8-2-09	7 A.M.	0	½ mile to the north.
8-2-09	12 noon	0	do.
	Muttuvaratu Paar.		
19-11-06	—	0	—
20-11-06	—	6	—
21-11-06	—	0	—
22-11-06	—	0	—
5-2-07	12-12.30 P.M.	0	—
(?)-2-07	12-12.30 P.M.	(?)	—
22-3-07	5-5.30 P.M.	6	—
23-3-07	8-8.30 A.M.	6	—
26-3-07	8-8.30 A.M.	0	—
18-2-08	8-8.30 A.M.	0	North end.
18-2-08	8-8.30 M.A.	6	do.
27-1-09	7.30 A.M.	0	—
27-1-09	9.30 A.M.	0	—
27-1-09	5.30 P.M.	0	—
28-1-09	12 noon	0	—
28-1-09	5.30 P.M.	0	1½ mile to the east.
29-1-09	7.30 A.M.	0	do.
	Dohnan's Muttuvaratu Paar.		
3-2-09	7.30 A.M.	0	—
3-2-09	12 noon	0	North end.
	Hamilton's Muttuvaratu Paar.		
1-2-09	5.30 P.M.	0	—
2-2-09	12.30 P.M.	0	—
4-2-09	7.30 A.M.	0	1½ mile to the west.
4-11-09	12 noon	0	do.

Date.	Time.	Depth in Fathoms of Net.	Position.
5–2–09	5 P.M.	0	1½ mile to the east.
6–2–09	7 A.M.	0	do.
6–2–09	12 noon	0	do.
	Krusadai Paar.		
14–11–06	(?)	6	—
17–11–06	(?)	1	—
19–11–06	(?)	1	—
25–11–07	8–8.30 A.M.	0	—
25–11–07	8–8.30 A.M.	5	—
26–11–07	8–8.30 A.M.	0	—
26–11–07	4–4.30 P.M.	5	West side.
27–11–07	8–8.30 A.M.	5	do.
15–2–08	4–4.30 P.M.	0	—
15–2–08	4–4.30 P.M.	6	—
16–2–08	8–8.30 A.M.	0	—
16–2–08	4–4.30 P.M.	0	South side.
17–2–08	8–8.30 A.M.	0	do.
	Dutch Bay Spit.		
30–1–09	5 P.M.	0	4½ miles north.
31–1–09	7.30 A.M.	0	do.
31–1–09	12 noon	0	4½ miles west.
	Talaivillu Paar.		
4–3–09	5.30 P.M.	0	—
5–3–09	7.30 A.M.	0	—
5–3–09	5.30 A.M.	6	—
	Navakkaduwa Paar.		
5–3–09	5.30 P.M.	0	—
6–3–09	7.30 A.M.	0	—
	Jokenpiddi Paar.		
11–3–09	7.30 A.M.	0	—
11–3–09	7.30 A.M.	6	—
	Karkopanni Paar.		
7–3–09	7.30 A.M.	0	—
	Chilaw.		
9–3–09	5.30 P.M.	0	—
	Nadalaikula Paar.		
4–3–09	7.30 A.M.	0	—
4–3–09	7.30 A.M.	6	—
	Bar Reef.		
29–1–09	5 P.M.	0	2½ miles north.
30–1–09	7.30 A.M.	0	—
—	12 noon	0	—

Explanation of Plates.

Plate XVII.

1.	*Undinula vulgaris* (Dana), var. ..	Left posterior thoracic margin, lateral view.
2.	*Undinula vulgaris* (Dana), var. ..	Left posterior thoracic margin, dorsal view.
3.	*Acrocalanus similis*, sp. nov. ..	♀, 3rd leg.
4.	*Acrocalanus similis*, sp. nov. ..	♀, 4th leg.
5.	*Acrocalanus similis*, sp. nov. ..	♂, 5th leg.
6.	*Scolecithricella pearsoni*, sp. nov...	♀, dorsal view.
7.	*Scolecithricella pearsoni*, sp. nov. ..	♀, 1st leg.

Plate XVIII.

1.	*Scolecithricella pearsoni*, sp. nov...	♀, 2nd leg.
2.	*Scolecithricella pearsoni*, sp. nov...	♀, 3rd leg.
3.	*Scolecithricella pearsoni*, sp. nov...	♀, 5th leg.
4.	*Scolecithricella pearsoni*, sp. nov...	♂, 5th pair of legs.
5.	*Centropages trispinosus*, sp. nov...	♀, lateral view.
6.	*Centropages trispinosus*, sp. nov...	♀, 1st antenna.
7.	*Centropages trispinosus*, sp. nov...	♀, 2nd leg.
8.	*Centropages trispinosus*, sp. nov...	♀, 5th leg.

Plate XIX.

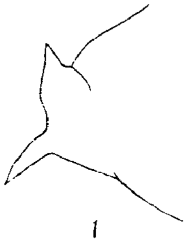
1.	*Acartia amboinensis*, Carl ..	♀, lateral view.
2.	*Acartia amboinensis*, Carl ..	♀, abdomen, dorsal view.
3.	*Acartia amboinensis*, Carl ..	♀, 1st antenna, basal joints.
4.	*Acartia amboinensis*, Carl ..	♀, Maxilliped.
5.	*Acartia amboinensis*, Carl ..	♀, 1st leg.
6.	*Acartia amboinensis*, Carl ..	♀, 3rd leg.
7.	*Acartia amboinensis*, Carl ..	♀, 5th leg.
8.	*Acartia southwelli*, sp. nov. ..	♂, 5th pair of legs.
9.	*Acartia southwelli*, sp. nov. ..	♀, 5th leg.

Plate XX.

1.	*Acartiella kempi*, gen. nov.; sp. nov.	♀, lateral view.
2.	*Acartiella kempi*, gen. nov.; sp. nov.	♀, 1st antenna.
3.	*Acartiella kempi*, gen. nov.; sp. nov.	♂, 1st antenna.
4.	*Acartiella kempi*, gen. nov.; sp. nov.	♀, 2nd leg.
5.	*Acartiella kempi*, gen. nov.; sp. nov.	♂, 5th pair of legs.

Plate XXI.

1.	*Labidocera pavo*, Giesbrecht ..	♂, dorsal view.
2.	*Labidocera pavo*, Giesbrecht ..	♂, grasping antenna.
3.	*Labidocera pavo*, Giesbrecht ..	♂, 5th pair of legs.
4.	*Acartiella kempi*; gen. nov.; sp. nov.	♀, 5th pair of legs.
5.	*Tortanus gracilis* (Brady) ..	♂, 5th pair of legs.
6.	*Tortanus forcipatus* (Giesbrecht) ..	♂, 5th pair of legs.



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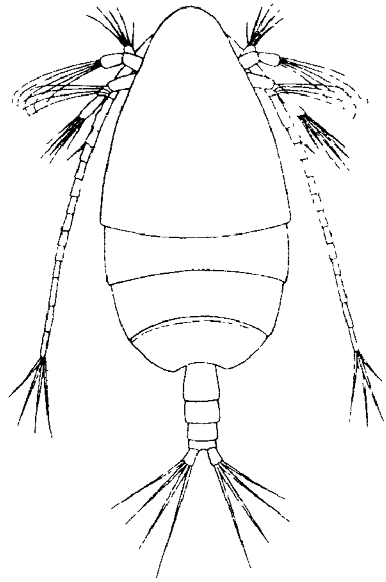

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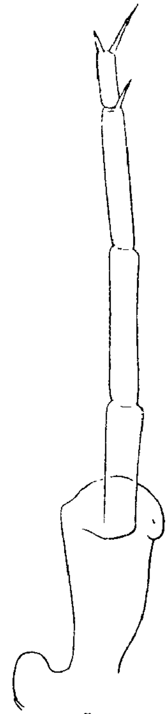

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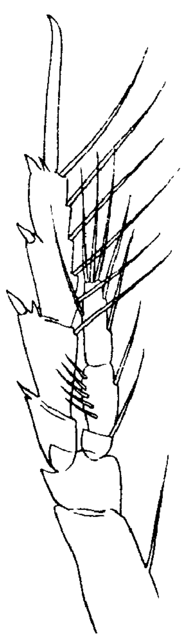

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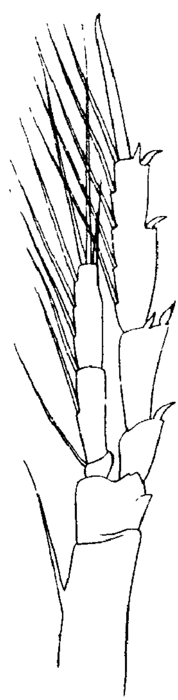

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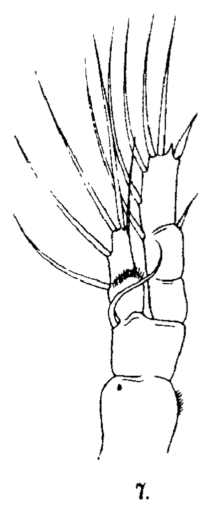

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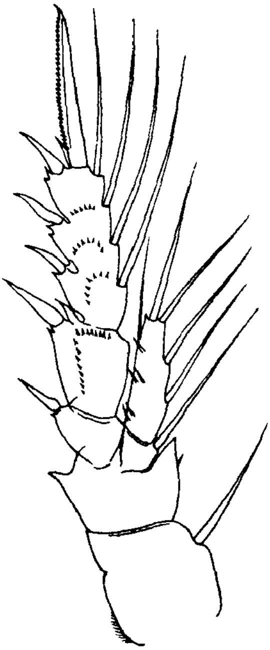

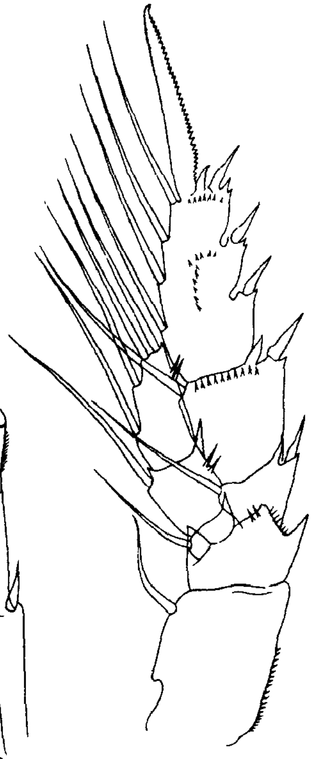

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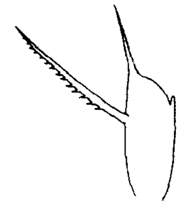

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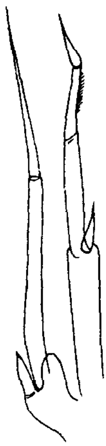

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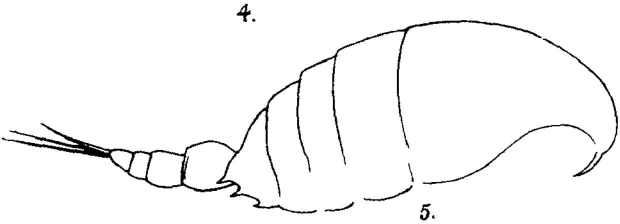

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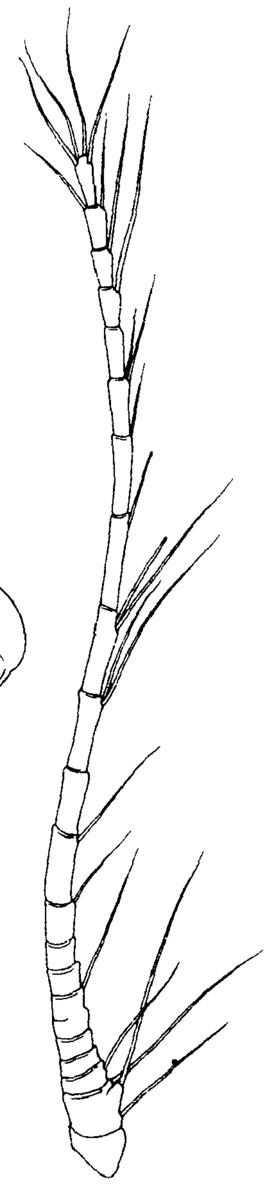

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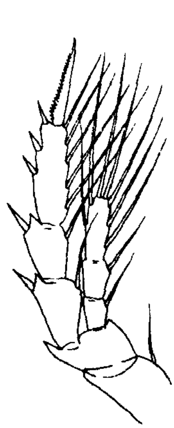

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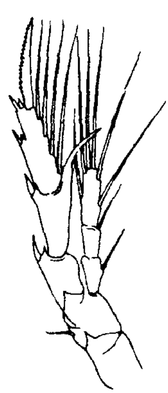

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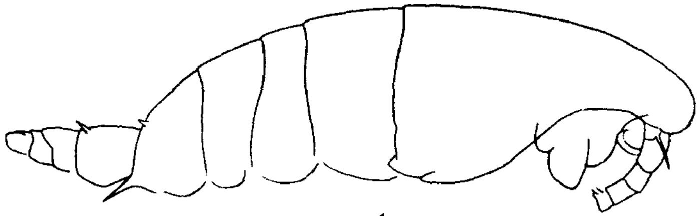

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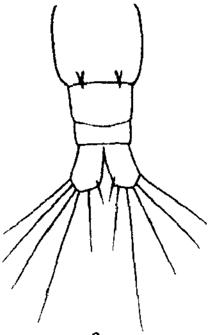

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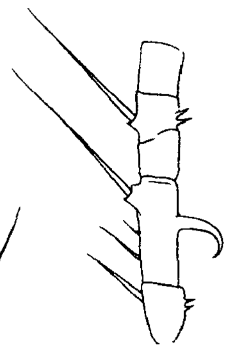

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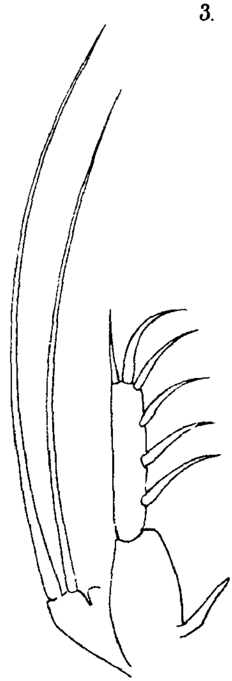

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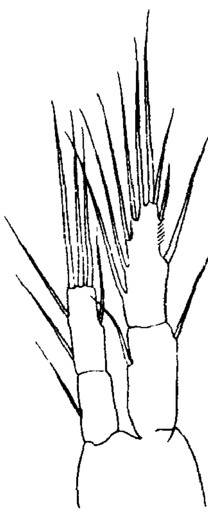

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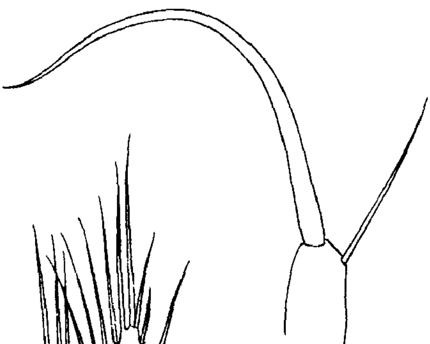

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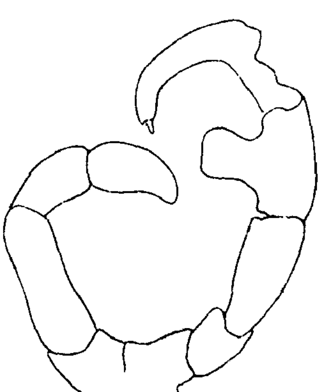

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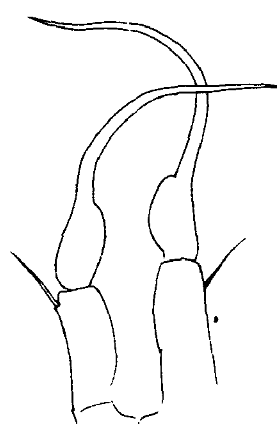

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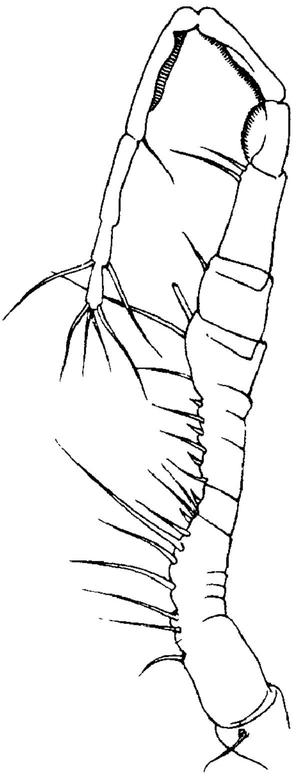

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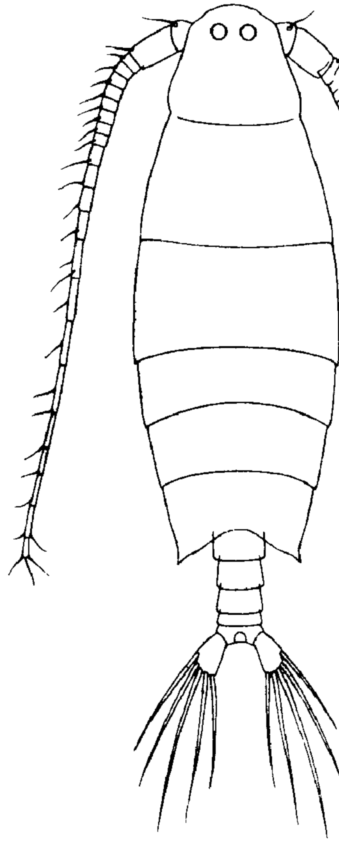

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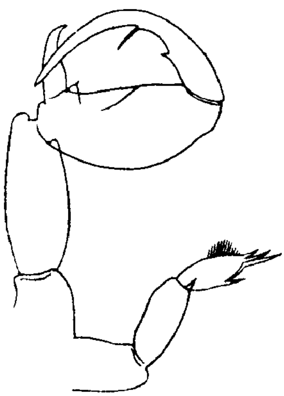

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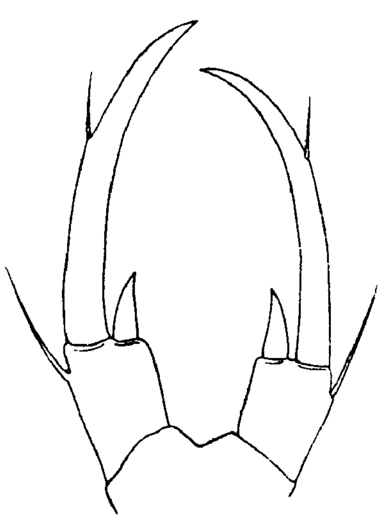

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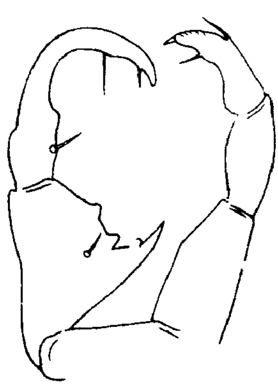

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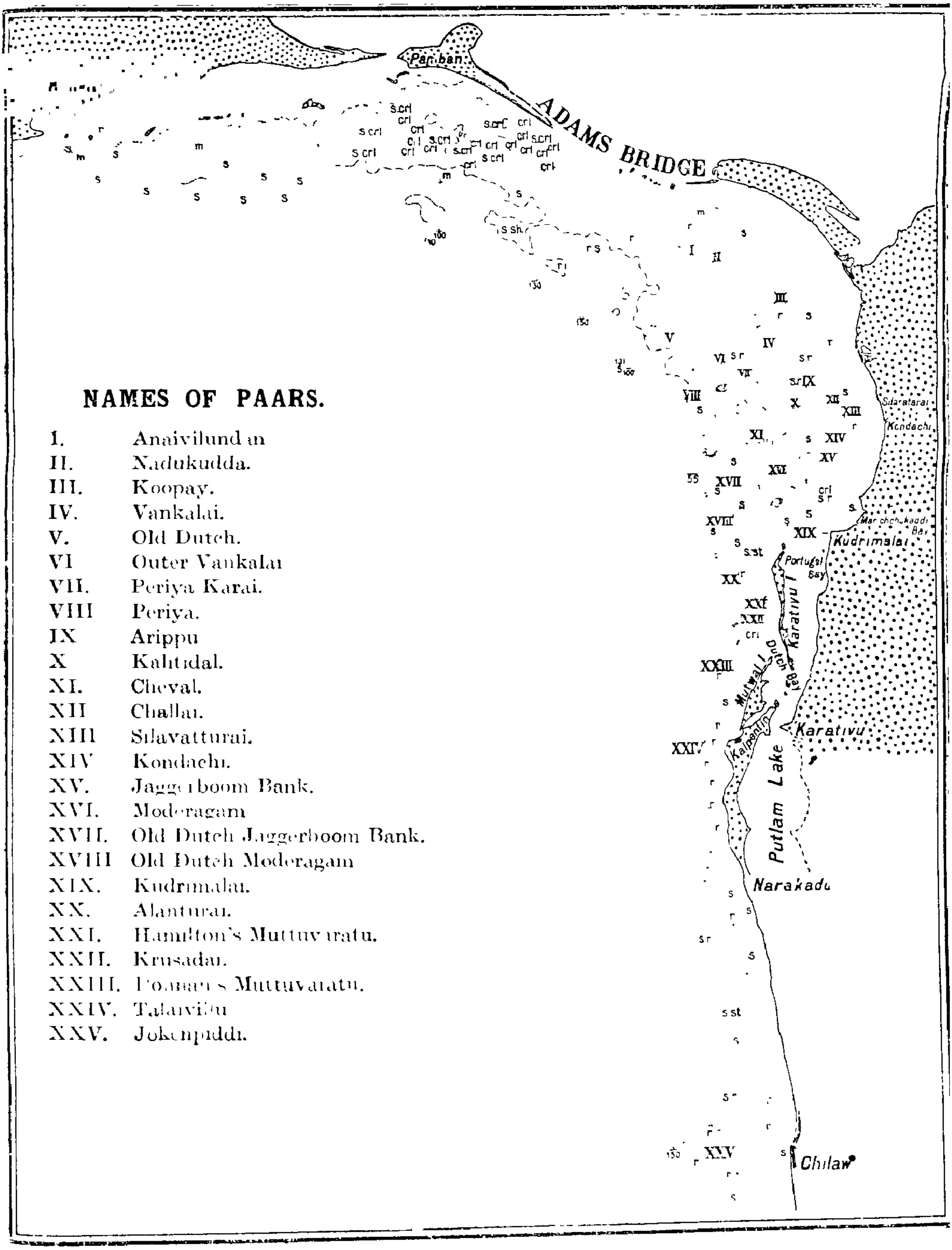

Map of the Gulf of Mannar.

REVIEWS.

1.—Ceylon Stone Implements.*

THE publication of this volume marks the first attempt on the part of a resident to give a connected account of stone-age discoveries in Ceylon and to formulate theories as to the uses to which the stones were put, their age, and their place in the great scheme of lithic remains which is being tentatively constructed by the efforts of European antiquaries, not without doubts, disagreements, and controversies.

Of these labours, it is to be feared that the late Mr. Pole was almost totally ignorant. Whenever the stone-age literature of Ceylon grows to respectable proportions and can be summarized and surveyed by a master of the science, honourable historical mention will always be accorded to Mr. Pole, who was not only the first in the field of inquiry, but who persisted in the face of incredulity and discouragement, until his discoveries, in themselves humble, were confirmed by the Doctors Sarasin and placed beyond dispute by subsequent investigations. The death of Mr. Pole in June, 1913, adds an additional pathos to the publication of the volume which he never lived to read, and renders the task of examining it in detail one of more than usual delicacy; but it would be a dereliction of duty to permit this work to go forth unchallenged as representing the reasoned conclusions of inquirers into the questions raised by his discovery of stone-age remains in Ceylon.

To the most casual reader it will be at once apparent that Mr. Pole was little qualified either by temperament or by acquired knowledge to decide these questions. Almost any stone showing signs of human fracture was to him an implement, to which he would confidently assign a use, with the result that the greater part of his collection was composed of

* "Ceylon Stone Implements," by John Pole, Scarborough estate, Maskeliya, Ceylon. Thacker, Spink & Co., Calcutta, 1913.

what others would discard as "chips." Thus, on page 8 we read that—

> With almost a total absence of secondary chipping any single chert flake might rank as a scraper, re-chipping is very rare.

On page 26—

> Should the material have fractured conveniently, little or no work was expended.

On page 31—

> Any flake may have been applied to this purpose, without having on it any mark of manufacture.

These passages show that Mr. Pole was unacquainted with the most elementary rules either of logic or of lithic manufacture. Scientific method imperatively demands the elimination of all specimens which do not carry upon their faces undeniable proofs of their human origin and design; and to introduce a number of "may haves" and "might have beens" is only to darken counsel. In the case of objects so debatable and so ambiguous as stone implements not unfrequently are, the inquirer must hold fast to the legal maxim, *De non apparentibus et de non existentibus eadem est ratio.*

Mr. Pole divides his book into two parts, one concerned with chert, the other with quartz implements, apparently for the sake of convenience and not as implying any difference in time or in phase of culture. There is, in fact, at present no reason for supposing that the two materials were not simultaneously employed. When, however, he quotes from the Doctors Sarasin that Ceylon quartz implements are to be assigned to the Magdalenian age, he is adopting a theory which will find little support among prehistorians acquainted with the facts, and which is almost certainly negatived by the recent discovery of pigmy implements. It was the misfortune of the brothers Sarasin that their stay in the Island was far too short for adequate collection and study of the material available; and their conclusions must be treated with corresponding reserve. It is also regrettable that they, as well as Mr. Pole, should have handled and actually published illustrations of pigmy implements without recognizing the type or the importance of the discovery. Several specimens figured in Mr. Pole's Pl. III. (quartz) are undoubtedly pigmies.

One word should be said concerning the supposed palæoliths figured in Plates I. and II. (chert). The probability of these dating back to the palæolithic age has the high authority of the late Mr. Bruce Foote. My own opinion on the subject, after an examination of the stones, is that it would be unsafe to regard them as certainly belonging to so early a phase, unless it can be shown that palæolithic types persisted in Ceylon till a very recent date, as was undoubtedly the case in Tasmania. According to my view there is nothing in the workmanship which differentiates them beyond controversy from a clumsy neolithic chopper or even core, while the unworn and recent appearance of the material contributes to throw doubt upon their extreme antiquity. It should be added that their type, if they were admitted to be palæolithic, would cause them to be referred to a pre-mousterian age, that is, to a period antedating the earliest complete skeletons which we possess from France and Belgium, the Neanderthal skull, and probably even the Gibraltar remains. There is nothing incredible in this theory; but for its acceptance it needs strong confirmation based upon a larger and more varied collection of stones than is at present available. Indubitable palæoliths will be discovered in Ceylon first, if at all, in gravel-beds.

I would add in conclusion that the Colombo Museum has lately acquired the whole of the late Mr. Pole's collection of stones. With the consent of the authorities I have gone carefully through the entire series, and among much that was worthless I have found a really considerable number of undoubted stone implements, including scrapers (round and hollow), borers, blades, and in particular over sixty pigmy implements of quartz. One large round scraper of chert is by far the finest specimen which I have yet seen from Ceylon, and is worthy of a place on the shelves of any Museum; of the pigmies, many are of the best type and deserving of the closest study. On comparing the available implements with the specimens selected for illustration in Mr. Pole's book, it is at once apparent that the author, with all his merits, was not qualified to distinguish the bad from the good. It is even more

lamentably obvious that he had the opportunity, by making a judicious selection from the stones in his possession, of producing a work which would have been of immense value to students, and which might have inaugurated a new era in the history of the Stone Age in Ceylon.

The illustrations contained in the book and contributed by Mrs. Maclure and Mrs. Harper are admirably done. It is melancholy to reflect that the excellence of their drawings renders the conviction so much the more inevitable that the majority of the stones figured are waste chips, not completed implements.

November, 1913. C. HARTLEY.

2.—Poisonous Snakes of India and Ceylon.*

THE enlarged third edition of Major Wall's book, which is published by the Bombay Natural History Society, and which treats so thoroughly with the posionous snakes of British India, is particularly well arranged and lucidly written, avoiding that complexity which so often characterizes books of this type, and which is so confusing to the general reader.

The first portion of the book deals with the identification of the poisonous snakes, chiefly by means of scaling and head shields, and is illustrated by clearly printed diagrams which should provo extremely useful, as the shields, which are often difficult to examine on a living specimen, are here clearly portrayed, and the necessary explanation is reduced to a minimum.

Each snake is concisely and clearly described, only those features that are necessary for its identification being given, to which are added short notes on its distribution, dimensions, colour, and poison. Of the "Kraits" Major Wall recognizes twelve species, two of which, *Bungarus ceylonicus* and *Bungarus cæruleus*, occur in Ceylon. The

* "The Poisonous Terrestrial Snakes of our British India Dominions (including Ceylon), and how to recognize them," by Major F. Wall, I.M.S., C.M.Z.S. 3rd edition. Bombay Natural History Society, 1913.

similarity in appearance of many of the "Kraits" has, up to the present, rendered their identification somewhat difficult except to the expert, and the author is to be congratulated on his "Key," in which the distinguishing characters of the snakes are ones that are easily discernable, being as follows :—The number of scales round the body ; the shape of the vertebral scales ; the number of ventrals and subcaudals, and whether the latter are divided ; the comparative width of the second supralabial ; the shape of the body ; the number of bars on body and tail. Particularly useful to the naturalist should be the different native names that are given of the commoner snakes, as much interesting information must often be lost through the casual observer, who is only able to obtain the native name of a snake, being ignorant of its English equivalent.

In the account given by the author of the cobras and coral snakes, the former are distinguished from the latter by the fact that the third upper labial in the cobra (counting from the nostral) touches both the nasal shield and the eye. The common cobra (*Naia tripudians*) may be distinguished from every other snake by the presence of a wedge-shaped scale (or scales, as there may be as many as three), the "cuneate" situated at the edge of the lower lip above the lower labials, and which may be hidden by the upper lip when the mouth is closed. The length of the two largest cobras recorded by the author is 6 ft. 7 in., one of which was killed in Colombo. The largest recorded Hamadryad, king cobra (*Naia bungarus*), which is distinguished by a pair of contiguous shields behind the parietals, was 15 ft. 5 in.

From the account given of the Pit vipers little appears to be known of the poison of many of them, but none of the cases of bites by these snakes, recorded by the author, terminated fatally.

The first portion of the book ends with descriptions of the Pitless vipers (Viperinæ), and those interesting snakes the *Vipera russellii* and *Echis carinata* are particularly described.

In the second part Major Wall gives a highly interesting account of snake poison, which includes the analyses of the different poisons, and the effects of their constituents on the

blood, while the symptoms produced by the bites of ten different snakes are fully described.

As Major Wall explains in his preface, the purpose of his book is to enable the general practitioner to determine a case of snake poisoning, the type of snake which inflicted the bite, and the treatment to be used, and as the subject of snake poisoning and its antidotes is exhaustively dealt with, the book should admirably fulfil its object.

The author begins this part with a chapter on death arising from complications due to fear of patients who have been bitten by innocuous snakes and even lizards, and compares the symptoms produced by fear with those of cobra-poisoning. Further on he gives the following summary of Colubrine and Viperine poisoning :—

> " Colubrine poisons act chiefly on the central nervous system (cord and brain), and cause death by paralysing the respiratory centre in the brain. Their effects upon the blood are slight compared with the viperine class, so that hœmorrhages are not usual, and when present are not severe."

> " Viperine poisons have no paralysing effect upon the nervous system, except on the vaso motor centre, but a very marked effect on the heart and blood, death being usually brought about by paralysis of the vaso motor centre, exhaustion from profuse and persistent bleeding, or from septicæmia (a blood poisoning due to germs)."

The third portion of the book deals with the treatment of snake poisoning—preventitive, antidotal (antivenene), symptomatic, and local treatments, also treatment to be adopted by non-professional people.

Major Wall appears to have made an exhaustive study of his subject; and his book, which has been considerably enlarged since its first edition, should prove of much value to all who are interested in snakes and snake poison, and arouse interest in those who are not.

A. F. ABERCROMBY.

Anuradhapura, November, 1913.

NOTES.

13.—*List of Birds found at and around Hakgala Gardens, Nuwara Eliya.*

Accipiter virgatus.—The Jungle Sparrow Hawk. Only seen occasionally.

Alcedo ispida.—The Little Indian Kingfisher. Occasionally seen in Nuwara Eliya, but never at Hakgala.

Munia kelaartii.—The Hill Munia. Very common; breeds all the year round, and occasionally uses the old nests more than once.

Amadina malacca.—The Black-bellied Munia. Seen in parties of five and six below Hakgala and on Albion estate, frequenting long grass on the patanas. Breeds from February to June. Common.

Arachnechthra asiatica.—The Purple Sun-bird. Occasionally seen at Hakgala.

Arachnechthra ceylanicus.—The Ceylon Sun-bird. Occasionally seen at Hakgala.

Brachypternus erythronotus.—The Red Woodpecker. Common all the year round.

Caprimulgus indicus.—Kelaart's Night-jar. Seen about here from December to May.

Centropus sinensis.—The Common Coucal. Fairly common from January to June.

Chalcophaps indica.—The Bronze-winged Dove. Generally seen in October and November; feeds on the fruits of *Sapium sebiferum.*

Cisticola cursitans.—The Common Grass Warbler. Seen nearly all the year round. Breeds in March and April.

Collocalia fuciphaga.—The Indian Edible-nest Swiftlet. Very common all the year round. Breeds from March to September. I have found nests of these in caves just below Hakgala. The young have their feet glued to the nest until they are able to fly.

Columba intermedia.—The Indian Rock Pigeon. Seen in October and November.

Coracias indica.—The Indian Roller. Rarely seen.

Corvus macrorhynchus.—The Jungle Crow. Fairly common in the villages below Hakgala. I often see a pair of these birds at Sita Eliya, just above Hakgala, elevation about 5,700 ft.

Crateropus rufescens.—The Rufous Babbler. I saw these for the first time in February last year in the thick jungle below Hakgala Peak. There were about fourteen of them together.

Culicicarpa ceylonensis.—The Grey-headed Fly-catcher. Common, especially during the N. E. monsoon.

Cyanops flavifrons.—The Yellow-fronted Barbet. Common nearly all the year round.

Dicæum erythrorhynchus.—Tickell's Flower Pecker. It is fairly common, and chiefly responsible for the spread of the Loranthus parasite.

Gallinago cœlestis.—The common Snipe. A few were shot this year near Hakgala in the middle of October.

Galloperdix bicalcarata.—The Ceylon Spur Fowl. Fairly common.

Gallus lafayettii.—The Ceylon Jungle Fowl. Common.

Geocichla spiloptera.—The Spotted Ground Thrush. Occasionally seen during the N. E. monsoon.

Geocichla Wardi.—Ward's Pied Blackbird. Seldom seen at Hakgala, but very common on Lower Albion estate during the N. E. monsoon.

Harpactes fasciatus.—The Ceylon Trogon. Rarely seen.

Hemipus picatus.—The Little Pied Shrike. Usually seen in the N. E. monsoon.

Hirundo javanica.—The Bungalow Swallow. Common in the N. E. monsoon.

Hypsipetes ganeesa.—The Black Bulbul. Common, except during the S. W. monsoon.

Kelaartia penicilata.—The Yellow-eared Bulbul. Very common nearly all the year round.

Lanius cristatus.—The Brown Shrike. Arrives here in the end of September.

Larvivora brunnea.—The Indian Wood-chat. Seen in the N. E. monsoon only; appears about October.

Molpastes hæmorrhous.—The Madras Bulbul. Occasionally seen at Hakgala, but common just below.

Melittophagus swinhoii.—The Chestnut-headed Bee-eater. Occasionally seen in the villages below Lower Albion estate during March and April, in threes and fours, but never seen at Hakgala.

Merops philippensis.—The Blue-tailed Bee-eater. Seen at the beginning of the N. E. monsoon in the villages below Hakgala.

Merula kinnisi.—The Ceylonese Blackbird. Common at Hakgala, especially during the N. E. monsoon.

Mirafra affinis.—The Madras Bush Lark. Seen all the year round, and breeds in February.

Motacilla melanope.—The Grey-and-yellow Wagtail. Very common during the N. E. monsoon. The first arrival seen here this year was on August 25, just below Hakgala.

Oreocincla imbricata.—The Buff-breasted Thrush. Occasionally seen in the N. E. monsoon. Rather rare.

Orthotomus sutorius.—The Indian Tailor Bird. Fairly common. Breeds from February to August. A nest was found on Lower Albion estate last April containing three eggs. The nest was built in a cinchona leaf.

Parus atriceps.—The Grey-backed Titmouse. Generally seen from January to May.

Passer domesticus.—The Common House Sparrow. Very few seen at Hakgala, but common just below.

Pericrocrotus flammeus.—The Orange Minivet Only seen occasionally.

Acanthopneuste nitidus.—The Green Willow Warbler. Common during the N. E. monsoon. The first arrival this year was seen on September 25.

Pomatohinus melanurus.—The Ceylonese Scimitar Babbler. Fairly common. Breeds during March, April, and May.

Pratincola caprata.—The White-winged Black Robin. Seen nearly all the year round, and breeds from January to June.

Prinia socialis.—The Ashy Wren Warbler. Fairly common; breeds about March, April, and May.. Eggs brick-red.

Sitta frontalis.—The Indian Blue Nuthatch. Usually seen during the N. E. monsoon in parties of four or five.

Spilornis spilogaster.—The Ceylonese Serpent Eagle. Fairly common.

Stoparola sordida.—The Ceylonese Blue Fly-catcher. Seen all the year round; fairly common from April to September.

Thereiceryx zeylanicus.—The Brown-headed Barbet. Occasionally seen at Hakgala, but common below all the year round.

Turtur suratensis.—The Spotted Dove. Seldom seen at Hakgala, but common in the villages just below.

Upupa indica.—The South Indian Hoopœ. Occasionally seen on Lower Albion estate.

Xantholæma hæmatocephala.—The Crimson-breasted Barbet. Seen below Hakgala nearly all the year round, and common from January to May.

Zosterops ceylonensis.—The Ceylonese White-eye. Very common all the year round, and breeds from January to July.

Zosterops palpebrosa.—The Common White-eye. Common on Albion estate. Never seen at Hakgala.

Hakgala, December 1, 1913. JAMES J. NOCK.

THE CEYLON NATURAL HISTORY SOCIETY.

Seventh General Meeting.

The Seventh General Meeting of the Society was held in the Colombo Museum on September 2, 1913.

Dr. A. Nell presided.

Major S. James, I.M.S., gave a lecture on "The Mosquito Work in Ceylon," which was illustrated by lantern slides.

Eighth General Meeting.

The Eighth General Meeting of the Society was held in the Colombo Museum on Tuesday, November 18, 1913.

Dr. Andreas Nell, Vice-President, presided, in the absence of the President.

Dr. Pearson gave an account of "The Natural History of the Window-pane Oyster (*Placuna placenta*)."

Dr. Pearson also exhibited several instruments intended for use in oceanographical investigations around the Ceylon coast. Among these exhibits were an Ekman current meter, a Nansen-Petterssen water bottle, and a Lucas sounding machine.

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